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American Wood-Preservers' Association

1922

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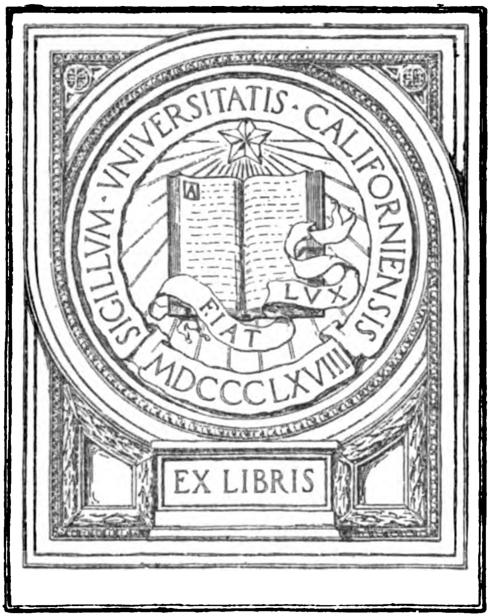

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AMERICAN WOOD-PRESERVERS' ASSOCIATION

PROCEEDINGS

OF THE

Eighteenth Annual Meeting

OF THE

American Wood-Preservers' Association

HOTEL SHERMAN

CHICAGO

JANUARY 24, 25, 26, 1922

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F. J. ANGIER

ELECTED PRESIDENT JANUARY 26, 1922

DECEASED MARCH 24. 1922

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LIST OF OFFICERS AND COMMITTEES

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W. H. Grady	First Vice President
H. S. Sackett	Second Vice President
S. D. Cooper	Secretary–Treasurer

Executive Committee

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Business

H. S. Sackett, *Chairman*
John Foley
C. F. Ford
E. J. Stocking
C. M. Taylor

Program

W. H. Grady, *Chairman*
R. J. Calder
S. D. Cooper
E. E. Pershall
O. C. Steinmayer

Committee No. 2—Publications

Geo. M. Hunt, *Chairman*

John Foley
C. M. Taylor

Committee No. 3—Service Bureau Board

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Walter Buehler
L. J. Colman
L. C. Drefahl
P. R. Hicks
R. S. Manley
Grant B. Shipley
E. J. Stocking

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Ernest Bateman
F. G. Breyer
J. H. Campbell
S. R. Church
L. C. Drefahl
J. H. Gibboney
F. W. Kroemer
L. J. Reiser
E. O. Rhodes
K. M. Waddell
Galen Wood

Committee No. 5—Treatment

5-1-1 Ties—Fir

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R. S. Belcher
J. E. Book
C. V. Caesar
R. H. Fairley
A. C. French
C. J. Hogue
Clyde Osborne
R. L. Wyman
C. W. Zimmerman

5-2 Lumber—Cars

F. S. Shinn, *Chairman*
K. C. Barth
H. C. Bell
Frank McCrory
S. M. Elder

Committee No. 5—Treatment—Continued.

5-5-1 Poles—Pressure

J. H. Dunstan, *Chairman*
C. D. Batson
R. C. Eggleston
C. C. Fritz
F. C. Krell
W. J. Smith

5-5-2 Non-Pressure Treatments

L. L. Hill, *Chairman*
C. H. Amadon
J. D. Burnes
E. T. Chapin
E. L. Clark
L. A. Furlong
P. J. Howe
E. A. Lindsley
W. K. Vanderpoel

5-9 Inspection

J. R. Keig, *Chairman*
J. M. Black
R. J. Davies
F. N. Graham
C. W. Greene
T. J. McGinty
E. N. Pelz
C. M. Tilley
J. A. Vaughan

Committee No. 6—Plant Operation

6-2 Adzing and Boring Ties for Treatment

Geo. E. Rex, *Chairman*
C. F. Ford
Andrew Gibson
C. E. Gosline
G. W. Lorenz
H. G. McElhinney

6-9 Cost Accounting

C. C. Schnatterbeck, *Chairman*
R. E. Kneeland
E. S. Park
W. P. Wiltsee

Committee No. 7—Utilization and Service

7-1 Track

Z. M. Briggs, *Chairman*
I. V. Bowden
E. H. Bowser
R. A. Bury
M. M. Rabourn
J. H. Waterman

7-3-1 Paving Blocks

L. T. Erickson, *Chairman*
P. L. Battey
Walter Buehler
E. R. Dutton
H. H. Horner
C. L. Humphreys
R. H. Moore
E. J. Stocking
R. H. White

7-9-1 Post Pressure

W. J. Smith, *Chairman*
J. E. Bernhardt
I. V. Bowden
F. G. Moore
Wm. Steen

Committee No. 8—Steam Treatments

Geo. M. Hunt, *Chairman*
J. D. MacLean
R. N. Angier
G. R. Hopkins
Bernard J. Niesse
E. N. Pelz

San Francisco Bay Marine Piling Committee

(In cooperation with National Research Council)

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A. A. Brown, *Vice-Chairman*
C. L. Hill, *Executive Officer*
W. C. Ball, *Secretary-Treasurer*

Ernest Bateman
A. M. Baxter
*Ralph Beebee
*J. C. Bennett
*G. W. Boschke
H. J. Brunnier
*J. S. Burd
*E. I. Clawiter
C. E. Cortes
Capt. Leonard M. Cox
*H. O. Demeritt
*Chas. Derleth, Jr.
*W. W. DeWinton
*W. E. Dore
*J. M. Evans
*H. F. Faull

San Francisco Bay Marine Piling Committee—Continued.

- *Emanuel Fritz
- *H. H. Hall
- *H. M. Goodman
- *G. H. Hicks
- *D. R. Hoagland
- Geo. M. Hunt
- *Capt. F. D. Jones
- L. D. Jurs
- *F. D. Kinnie
- W. H. Kirkbride
- Dr. C. A. Kofoid
- *C. A. Kupfer
- *C. B. Lipman
- *Lieut. C. L. Macrae
- Chas. R. McCormick
- *Walter Mulford
- *F. Neitzel
- *Jerome Newman
- *H. S. Pond
- *C. W. Porter
- R. H. Rawson
- *G. W. Rear
- *Ralph J. Reed
- Capt. H. W. Rhodes
- *W. T. Richards
- *A. A. M. Russell
- *W. L. Shaw
- *F. B. Smith
- *O. K. Smith
- R. G. Smith
- *H. M. Smitten
- *H. E. Squire
- *J. J. Walsh
- F. G. White
- J. W. Williams
- *Lieut. H. E. Wilson
- Herman von Schrenck

---

* Not members of American Wood Preservers Association.

Gulf Coast Piling Committee

- E. E. Boehne, *Chairman*
- A. F. Fant
- R. S. Manley

Properties of Treated Wood

- A. R. Joyce, *Chairman*
- E. B. Babcock
- F. G. Breyer
- Walter Buehler
- H. R. Condon
- G. M. Davidson
- W. H. Fulweiler
- A. L. Heim
- C. J. Hogue
- P. J. Howe
- R. A. McKee
- C. E. Paul
- S. J. Record
- W. K. Vanderpoel

Forestry

- John Foley, *Chairman*
- H. E. Horrocks
- H. S. Sackett

To Revise the Constitution Relative to Service Bureau Board

- John Foley, *Chairman*
- E. B. Fulks
- Geo. M. Hunt
- Geo. E. Rex
- J. H. Waterman

To Study and Make Recommendations as to Ruling of Interstate Commerce Commission Regarding Disposition of the Charge of Cost of Treated Ties

- Earl Stimson, *Chairman*
- Grant B. Shipley
- C. C. Schnatterbeck

Tropical Hardwoods

- Nelson C. Brown, *Chairman*
- Arthur Koehler
- E. C. Mandenberg
- S. J. Record

Highway Bridge Fire Hazards

G. W. Booth, *Chairman*	D. F. Holtman
L. T. Ericson	E. E. Kelley

Committee on Preparation of Manual

John Foley, *Chairman*	C. M. Taylor

American Engineering Standards Committee

J. H. Waterman, representing		AWPA
John Foley,	"	AREA
A. L. Kuehn,	"	ASTM
W. C. Nixon,	"	NARRTP
H. S. Betts,	"	U. S. Forest Service

UNIV. OF CALIFORNIA

OPENING SESSION

The Eighteenth Annual Meeting of the American Wood-Preservers' Association was held at Hotel Sherman, Chicago, Illinois, January 24, 25, and 26, 1922. The President, Mr. C. Marshall Taylor, called the first session to order, on Tuesday, January 24th, at ten thirty o'clock A. M.

THE PRESIDENT: The Eighteenth Annual Convention of the American Wood-Preservers' Association is called to order. [*Applause.*] We will be led in prayer by a man who has become the dean of our membership, Mr. J. H. Waterman.

MR. WATERMAN: Our Father, we thank thee for the privilege of meeting with these men. We thank Thee for all the blessings that Thou dost bestow upon us. We thank Thee for our beautiful land. We thank Thee for our government. We thank Thee for our homes, and now, as we are gathered together here, men interested in wood preservation, we pray Thee that Thou wilt meet with us, and wilt Thou enthuse every man here to do his best, that he may preserve the wonderful gifts that Thou has given us in our forests, not only for us but for the generations yet to come. We pray Thee that Thou wilt help us to discuss together the things which will be of most interest to us all and may love run through the midst of all our discussions. May we be frank and honest and kind and loving, but let us be fearless and speak forth those things which we believe are for the best interests of our organization. We thank Thee that it has been possible that such a great body of men, intelligent men, may gather together year after year that they may promote the best interests of this industry. Now we pray Thee to guide us in the way we should go, and when we go to our homes may we think and remember the good things that we gather here and the things that may be unpleasant may we forget and let them drift away. We ask it all in the name of Jesus Christ, our Saviour. Amen.

THE PRESIDENT: Ladies and Gentlemen, it certainly is a pleasure to see so many of you here this morning. Nothing looks better for a convention than a large attendance at the opening session.

It is with great pleasure and I assure you that it is quite an honor to have address us this morning a man who means much to the United States these days. You know what the railroads mean to this country, and hear of what the roads have to do in order to stimulate business in this country. We know that in the American Railway Association we have the strongest association of any railroad group in the world, which is doing everything it possibly can to meet the emergency that exists in the railroad situation to-day. Its President, who has been in the railroad game all his life, is willing to spend a few minutes with us this morning to put before us the situation as he sees it. Mr. Aishton. [*Applause.*]

MR. R. H. AISHTON: Mr. President and Ladies and Gentlemen of the American Wood-Preservers' Association: It is a particular pleasure to me to meet with you at this time, because for the last week or two I have been consulting with people and doing some talking down in Washington on the question of efficiency of the railroads.

Under the Transportation Act one of the duties of the Interstate Commerce Commission and of public authorities is to provide rates, that will produce a reasonable return to the carriers, provided in their opinion the roads are efficiently and economically operated. That one question has raised considerable comment back and forth, from different quarters. We read in the newspapers, for example, as I did a week or ten days ago, while in the East—I do not believe everything I read in the eastern papers, I try to get my information from the Chicago papers [laughter]—but it was stated with a very great degree of exactness that it was possible to save three hundred and fifteen million dollars per year in the consumption of fuel on locomotives by the railroads, by certain simple devices that could be installed on locomotives. Well, that thing created a lot of comment, and when you consider that the total fuel bill for the railroads, I think, is something around six hundred and fifteen million dollars a year, wny, it indicates a possibility of a very tremendous saving. Now it does not do to criticise those things or pick them to pieces. One of the functions of the American Railway Association is to take all those things and try to develop what there is in them. A similar case is Mr. Ford's railroad at Detroit. Mr. Ford made a wonderful showing the first two or three months. There has been a good deal of comment aimed at Mr. Ford and his methods. The railroads generally as a result of this information have attempted to see whether there is really any real lesson it it for them and whether the methods that brought this result are worthy of emulation.

Now, what you are doing in this matter of wood preserving is fine, but I want to tell you that you need a press agent. You need a press agent badly, I think. For ten or fifteen years I was actively thrown into the wood-preserving game as I was connected with a road which believed in that kind of thing and naturally I became interested in it and went along with it and believed in it—but do you know that I never knew that of all the timber that is treated in the United States, 90 per cent is railroad timber. Ninety per cent of all the timber that is treated in this country is railroad timber. A striking evidence of the efficiency of railroad management.

When you come to look at the figures of the timber actually treated in this country, why shouldn't we become enthusiasts on the subject? I joined in your prayer today, the very eloquent prayer by one of your members. He referred to the great work you are doing in the conservation of these magnificent forests. What American citizen can go through these forest areas without feeling that as a citizen it is his duty to preserve every tree that he possibly can, and if you can help do it by the work of your association you are performing a great public duty.

The other side that I referred to, the question of efficiency of the railroads and its relation to lowered costs; I do not know what the records of your Association have developed, but I have no doubt there is a tremendous economy. There is no doubt that there is a tremendous economy in your work, and in that economy today every citizen of this country is interested. The work you are performing is not only a work for yourself and a work for the railroads, but a tremendous public service to the people of these United States, and I know they will appreciate it as these results become better known.

I have no doubt that in your conference here you will reach conclusions on all those things. Now I just want to give you one word of advice. I have been giving that same word of advice to the various committees of the American Railway Association. The American Association is a purely voluntary association. It has no power whatever, except the desire of the railroads and of all railroad officers to improve methods. I do not know of any class of men in any industry in the world who have a greater desire to adopt the most efficient methods than the railroad officers and through this American Railway Association they are enabled to get the concentrated opinion and advice of experts in their particular line of business. Now heretofore there has been some criticism of all these voluntary organizations in that the work they perform is not effective. I have said to the Divisions of the American Railway Association, Gentlemen, the fault lies with yourselves. You have one function that you don't perform. You manufacture a splendid line of goods. Your committee papers receive consideration, they receive discussion, they are amended, and they are finally adopted, generally unanimously in some form, and in every one of them there is a germ of something that is valuable to every member in your organization. I recommend that you do just one more thing. When you agree here on a report and you have amended it, and you agree possibly by unanimous vote, or there may be some objection, but when you have done that your work is not done. When you go home after you have reached a conclusion on something that clearly is of benefit, that will produce economics and that will produce efficiencies, sell it to your own people, and when you have done that you will make progress just twice as fast as you have in the past. That is the only advice I can give you, and in conclusion I want to say to you that it is a very great pleasure for me to meet with you here. [*Applause.*]

THE PRESIDENT: Next is the report of the Secretary-Treasurer, Mr. Hunt.

REPORT OF THE SECRETARY-TREASURER

To the Members of the American Wood Preservers' Association:

Gentlemen: The year 1921 marked a radical change in the office of the Secretary-Treasurer. After many years of untiring service Mr. Angier was promoted by the Association to a higher office, and a new and untried man was put in his place. The transfer of the office after so long a stay in one place, and the breaking in of a new secretary naturally caused some inconvenience, but every effort has been made to continue the high standards previously maintained in this office.

During the year some progress was made towards a manual of standard practice. A letter ballot was held on all the standards thus far legally recommended for adoption as standards of the association. All the items on the ballot passed by large majorities and they are now the adopted standards of the Association.

A list of the items with page references to the various proceedings in which they have been published follows, together with the financial statement and membership statistics.

Standards Adopted by the A. W. P. A.

Item	Published in Proceedings of	Pages
Iodine-Potassium Ferricyanide test	1920 & 1921	182
Specification for treatment of creosoted Douglas fir paving blocks	1921 Committee Report	
Specification for pitch paint coat method of construction for street pavement work (amended from 1918 proceedings)	1919	108-109
Standard peeling for poles and piles	1918	72
Definition of interior wood block floors	1918	96
Specification for interior wood block floors (as amended on page 108)	1918	97-101
Definitions of processes (as amended, pages 65 to 75)	1917	76-81
Standard temperature for measuring creosote	1917	254
Table for expansion of creosote	1917	242
Volume of piles and poles	1917	249
Specification for water gas tar (see pages 363-364)	1917	328-336
Qualifying paragraph for specifications for creosote coal-tar solution (see page 28, 1920 proceedings)	1917	365
Definition of tar	1917	280
Definition of Creosote	1917	280
Specification for zinc chloride (amended as on page 177-194, 1918 proceedings)	1917	326
Specification for creosote for ties and structural timber	1917	307
Specification for creosote coal-tar solutions for ties and structural timbers (amended, page 177, 1918 proceedings)	1917	307
Specification for coal tar oil for paving blocks (amended as on page 177-180. 1918 proceedings)	1917	308
Specification for distillate oil for paving blocks	1917	308
Method of analysis for zinc chloride	1917	280
Determination of amount of water	1917	309
Determination of amount insoluble in benzol	1917	310
Determination of specific gravity	1917	312
Distillation test	1917	313
Determination of Specific Gravity of fractions	1017	316
Float test	1917	319
Determination of coke residue	1917	320
Explanation of expression 38°/15.5°C	1918	174-175
Parts printed in italics in report of Committee on Purchase and Preservation of Treatable Timbers (see also discussion and ammendments previous to report)	1917	413-427
Specification for creosoted wood block paving	1917	454-461
Paragraph D, beginning page 263. See also page 285	1915	263

The next increase in membership was less in 1921 than in 1920. There was a smaller number of new members secured than in 1920 and a larger number were dropped for one reason or another. Our membership on January 1, 1922, was 409, which is a net gain of 36 during the year.

New members bring new ideas and new enthusiasm. They help us to keep out of ruts. As our membership increases our power to

spread the gospel of "conservation by preservation" increases and we have new opportunities for service. Let us keep this in mind in 1922.

Financial Statement

Cash on hand, December 31, 1920		$379.74
Liberty Bond on hand, December 31, 1920		500.00

Receipts

Admission fees	$630.00	
Membership dues	3,725.10	
Advertising—Proceedings (1920)	150.00	
Advertising—Proceedings (1921)	1,075.25	
Sales—Proceedings	864.90	
Sales—Handbook	8.07	
Sales—Decay of Ties	100.60	
Sales—Reprints	46.00	
Sales—Piling Report (For S. F. Committee)	11.00	
Loan from Service Bureau	500.00	
Interest—Bank Deposits	2.60	
Interest—Liberty Bonds	21.25	
		7,134.77
Total cash, bonds and receipts		$8,014.51

Disbursements

Proceedings:		
Printing (1920)	$998.04	
Printing (1921 on account)	1,600.00	
Printing Advance Papers (1921 convention)	1,567.66	
Reporting	156.00	
Editing and soliciting advertisements	131.40	
Express and storage charges	32.60	
San Francisco Piling Committee	100.00	
Refund on 1920 Proceedings	3.75	
Refund on 1920 Advertising	40.00	
Compiling Statistics for 1922 proceedings	60.00	
	$4,689.45	
General:		
Expense—Secretary-Treasurer's office	$999.99	
Stationery, postage, express and telegrams	578.48	
Expense—1921 Meeting	198.75	
Printing—Programs for 1921 Meeting	151.75	
Printing—Ballots	39.00	
Printing—President's Bulletins	50.25	
Printing—Application Blanks	25.85	
Membership—Association of Wood Using Ind.	100.00	
Membership—U S. Chamber of Commerce	20.00	
Membership—National Conservation Ass'n	5.00	
Proceeds of Piling Report sales, (paid to S. F. Committee)	11.00	
Service Bureau Note	500.00	
Interest on above note	5.00	
Flowers, E. M. Blake's funeral	25.00	
Refund on excess admission fees received	20.00	
Checks returned—"no funds"	30.00	
Collection and Exchange	5.17	
	$2,765.24	
Total disbursements		$7,454.69
Cash on hand, December 31, 1921	$59.82	
Liberty bond on hand, December 31, 1921	500.00	
		559.82
		$8,014.51

Membership

Last annual report			373
Enrolled since last report		60	
Resigned	11		
Dropped	10		
Deceased	3		
		24	
Total net gain			36
Membership, December 31, 1921			409
Corporate		309	
Associate		90	
Probate		4	
Honorary		6	
		409	

THE PRESIDENT: You have heard the Secretary's report. The office of the Secretary–Treasurer is much more arduous than it was when we first started, and it is bound to grow more so. Every one should do everything in his power to help the person who is Secretary–Treasurer.

The Chairman of the Entertainment Committee will announce the entertainment provided for the convention.

Mr. E. J. Stocking then presented the details of the entertainment program.

THE PRESIDENT: It is necessary at this time to appoint certain committees. The first is the Auditing Committee and the appointments on that committee are: Mr. Schnatterbeck, Mr. Curtin and Mr. Meyer. The Tellers' Committee will consist of the following: Mr. Mattos, Chairman; and Messrs. S. D. Hicks, Grow, Bradley and Clifton. The Resolutions Committee will consist of: Mr. Briggs, Chairman, and Messrs. Harper, Walters, Boehne, Amadon, G. C. Dixon, Dutton and L. B. Moses.

The National Association of Railroad Tie Producers meet during this week and we are to have a joint banquet with them. It is a pleasure to have so many of their members with us. We hope they will take every opportunity to make themselves heard, and will feel at home amongst us.

In making what is supposed to be an address, I wish I were like Mr. Aishton and had somebody who could write it for me. Mr. Aishton left a very strong point with us, and I trust that not only the Service Bureau Board but every one in our Association realized what he said to us when he told us that we needed a press agent.

There are some of us who can advertise well our own possibilities. We can brag amongst ourselves, about how well we do it, but that will never put the American Wood-Preservers' Association where it should be in the United States. It is very easy to drift along and not take advantage of our opportunities. That a man like Mr. Aishton could be so long and closely identified with railroad work and not be aware of the fact that the preservative treatment of wood means so much to railroads today ought to set back some of us who have been bragging about how much material we have treated on our individual railroads.

The point about the situation is that we have been bragging among ourselves entirely too much, and not spreading the gospel of wood preservation more. It is all right for us to come here and have our discussion, but we need to broadcast the benefits of our work.

As we become better known we must become better wood-preservers. The day is gone when we could put some oil into a cylinder and make timber black. We have to produce satisfactory goods.

There are in wood-preservation, other fields besides those we have been familiar with. It seems to me that we are wasting time in not branching into new fields. We are too well satisfied with the cross-ties that have given a life of twenty years, and pat ourselves on the back and say we have done a good job. No industry that rests on its past performances will survive. We must branch out, and it behooves the Service Bureau and the aggressive ones in our membership to develop new fields of wood preservation, so that we may truly become conservers of our forest resources.

During the past year there has been some discussion of the ideas that has been in the minds of some of us for several years, as to whether we are using our oils to the best advantage, or always sure that the oils are what they should be. The Preservatives Committee report which will be given this afternoon will warrant the attention of every one of you.

In connection with creosote we have at the Forest Products Laboratory a man known to all of you, Mr. Bateman, who has been giving us new ideas. They seem logical. Just because the oils have been black in the past has not made them good, but it has been our good fortune that they have been effective. They had something in them that did the work. Through the studies of Mr. Bateman and others in toxicity we are developing what we really did to the timber when we did not really know what we were doing other than trying to preserve it.

The meeting on Wednesday afternoon will be devoted to the Service Bureau and allied subjects. The Service Bureau is barely six months old and has made wonderful strides thus far. Any new scheme has its trials and tribulations, but I can say in advance of the report that the Service Bureau has the confidence of the industry. [*Applause.*]

I wish to speak just a minute on the confidence that the railroad men have in the Service Bureau. As it develops new fields for preservation in all lines of wood construction the railroads in their zest for economy will naturally use these developments, and every railroad man in the Association should boost the Service Bureau.

The thought I wish to leave with you in connection with this Association is like a definition of a successful man. A successful business man is one who has the horse power of an optimist, and the emergency brakes of a pessimist. I trust that we will never have to use our emergency brakes, and I hope that our horse power may be increased as time rolls on. [*Applause.*]

Next will be the report of the Publications Committee.

REPORT OF COMMITTEE 2—PUBLICATIONS

MR. C. C. SCHNATTERBECK: Gentlemen, do you know that fully 80 per cent of your annual dues as members of the Association is used to pay the deficit resulting from the publication of the Annual Proceedings alone?

To appropriate 80 per cent of the annual revenue from the membership to liquidate the annual indebtedness of some $3,000.00 on a publication that costs in the neighborhood of $5,000.00 to print and distribute is, I believe, a very forceful argument why we should try to increase our membership if we expect ever to issue the *Manual* and other needed literature.

That the members may better understand the finances of our publications I have prepared a balance sheet from 1910 to 1921, inclusive, the period during which the membership increased from 67 to 409.

Finances of All Publications

	Receipts	Expenses	Loss	Loss per Member	No. of Members
1910	$632.40	$793.66	$161.26	$2.41	67
1911	1,187.20	1,447.29	260.09	2.50	104
1912	1,714.91	2,008.05	293.14	1.87	157
1913	1,577.70	2,203.55	625.85	3.24	183
1914	1,551.52	2,534.88	983.36	3.71	265
1915	2,129.57	3,733.94	1,604.37	5.81	276
1916	2,356.28	4,356.78	2,000.50	6.69	299
1917	3,610.75	5,658.51	2,047.76	7.08	289
1918	2,920.80	3,337.42	416.62	1.48	282
1919	1,363.66	3,489.67	2,126.01	6.97	305
1920	2,071.93	5,074.07	3,002.14	8.05	373
1921	2,157.57	5,492.61	3,335.04	8.15	409

The above statement does not include credit for publications unsold at the end of any year, which, however, is an important factor in computing the assets and liabilities of the Association.

Since the Proceedings occupy such an important position in the affairs of the Association, it is of interest to show in the statement below details comprising the receipts and expenses for the five years from 1917 to 1921 inclusive:

Cost of Annual Proceedings
(Including Reprints)

Receipts

	1917	1918	1919	1920	1921
Sales	$223.28	$191.90	$263.32	$439.48	$864.90
Advertising ..	1,045.63	1,055.02	1,080.50	1,394.10	1,184.00
Total	$1,268.91	$1,246.92	$1,343.82	$1,833.58	$2,048.90

Expenses

	1917	1918	1919	1920	1921
Printing	$3,042.22	$1,567.50	$3,079.14	$3,787.35	$4,839.71
Reporting	202.00	123.00	172.11	159.40	156.00
Statistics	60.00	51.50	60.00	60.00	60.00
Copyright	1.25	1.35	1.25	1.25	1.25
Editing	169.81	103.18	124.80	149.41	131.40
Postage & Exp.	96.10	59.29	49.37	90.82	209.00
Miscellaneous.	32.81	12.44	3.00	22.00	45.00
Total	$3,604.19	$1,918.26	$3,489.67	$4,270.23	$5,442.36
Deficit..	$2,335.28	$671.34	$2,145. 5	$2,436.65	$3,393.46

In explanation of the high cost of printing the 1921 Proceedings ($4,837.71) it will be of interest to mention below the items that have contributed to this expense:

Printing matter other than the Marine Piling Report	$3,359.45	
Less credit on type and cuts standing from the advance papers published for distribution at 1921 meeting.............	721.75	
		$2,637.70
Marine Piling Report..		258.60
Advance papers for 1921 meeting—		
Marine Piling Report	100.00	
Other Committee Reports, etc..............	1,567.66	
		1,667.66
Reprints from Proceedings................................		275.75
Total printing cost..............................		$4,839.71

Another feature in connection with our Proceedings is the time of its appearance for distribution from the press-room. Perhaps the members not acquainted with the trials and tribulations of the publishing business would like to learn why there has been so long a delay in getting out the Proceedings. Prompt publication is desirable, and although your Committee on Publications every year entertains this expectation, circumstances have and may continue to prevent its realization. Taking the 1921 Proceedings as an example to illustrate the cycle of operation in publishing the annual volume:

From the close of the last annual meeting on January 27, 1921, to May 16, 1921, when the manuscript of the minutes of the meeting was received from the Secretary by the Committee on Publications, is an interval of nearly four months. Most of this time was consumed in forwarding to the members the transcription of their remarks on the floor of the convention and urging them to send to the Secretary any corrections necessary.

One week after its receipt, the Committee on Publications had ready for the President's approval the manuscript received on May 16. On June 2 the President read and O. K'd the edited manuscript, and within twenty-four hours the same was delivered to the printer.

The first proof was received from the printer on June 10, and a week later there was received from the Secretary and immediately sent to the printer the manuscript of the list of members, officers and committees. The only part of the volume missing was the report on the San Francisco Bay Marine Piling Survey, printed by special arrangement at Berkeley, California. On June 22, our Washington, D. C., printer, on request of the Committee on Publications, sent instructions to the California printer how to prepare and deliver the reprints of this report for binding in the Proceedings. The final paging of these reprints was sent to the California printer on July 14 when our Washington printer had set up the other manuscript up to this point.

On August 24, less than three months after our Washington printer received the first manuscript, he turned over to the Committee on Publications a roughly bound copy of the Proceedings (exclusive of the Marine Piling Report, which up to this time had not been received). Not until a month later, on September 22, were the reprints of the Marine Piling Report received by our Washington printer for inclusion in the Proceedings.

Notwithstanding the lŏng delay at the California end in delivering the Marine Piling Report to the Washington, D. C., printer, the completely bound volume of the 1921 Proceedings was placed in the hands of the Committee on Publications on October 1, 1921, less than five months after receipt of the first manuscript from the Secretary, on May 16, 1921.

The 1921 Proceedings, comprising 590 pages of text and 32 pages of advertising, is the largest and, naturally, the most expensive in the history of the Association.

MR. BUEHLER: Mr. President, as a member of the Publications Committee I do not care to sail under false colors. If there is any credit due for the publication it should be given entirely to Mr.

Schnatterbeck, as we placed the entire burden of getting out that publication on his shoulders.

THE PRESIDENT: Regardless of whether all the committee worked or whether only part of it worked the Publications Committee did a good job this year, and they are to be congratulated. There is one point I wish to mention here. Each year the Forest Service collects data from each treating plant as to the quantity of preservatives and the quantity of material used. One of the last things we got for our annual proceedings was Mr. Helpenstine's report, and it was not his fault. It is the fault of some fellow here or there in the industry who doesn't compile his annual statistics in time to get them to the Forest Service promptly. Each of you know now just how much you treated last year. If you don't you ought to, because you knew ahead of time that the report is requested annually, and this year pray give your report promptly. It will mean a lot toward getting out our annual proceedings early. Another thing, the report is not sent in from every treating organization in the United States. The reports come from the majority, and the Forest Service has to estimate possibly on one, two, three or four plants. That should not be necessary. The figures should come from everybody.

MR. GOLTRA: Mr. President, does the Forest Service collect data for material treated by non-pressure processes?

THE PRESIDENT: Yes, from commercial plants using such processes.

MR. GOLTRA: I believe that there is a lot of material treated by non-pressure processes that ought to be included in his statements. I have treated considerable quantities of material by the open tank process, but do not recollect of ever receiving an inquiry regarding the quantity or kind of material treated by my company. I suppose that there are hundreds of concerns in the United States that treat material of one kind or another by non-pressure processes, with different preservatives, the aggregate quantity of which would be surprising. I believe that manufacturers of wood preservatives of various kinds would be willing to furnish the names and addresses of users of their preservatives, and from whom the desired data could be obtained. However, I am not sure that this scheme would be feasible.

THE PRESIDENT: The first paper on our program is that by Dr. Snell, on the "Effect of Heat on Wood-Destroying Fungi in Mills." Dr. Snell is one of the professors at Brown University and is doing a lot of work along these lines. He was formerly located in the Forest Products Laboratory at Madison, where he got his ground work in connection with the fungi problem, and it is fine that we can keep his interest in our industry. As Dr. Snell is not here the Secretary will present the paper at this time.

THE SECRETARY: Dr. Snell was formerly in the Laboratory of Pathology of the Bureau of Plant Industry, which operates in cooperation with the Forest Service. He was associated with Mr. Humphrey.

THE EFFECT OF HEAT UPON WOOD DESTROYING FUNGI IN MILLS

Walter H. Snell, Ph. D.

Department of Botany, Brown University
Providence, R. I.

The use of heat for checking decay in buildings has been suggested by European writers, but little has been done to test its efficacy. Hoxie[1] in this country reports an experiment carried out in a mill infected with true dry rot. The mill was heated up by means of its own heating system four different times from Saturday noon to Monday morning to about 115° F. The results in this case were very encouraging. If it should prove generally feasible to control decay in buildings by low degrees of heat applied by installed heating systems, such a procedure would have very far-reaching results. The troubles caused by decay would soon come to an end, for it would be a simple and relatively inexpensive matter to keep a high heat on over week-ends, during shut-downs, etc. The possibility would mean much to construction and preservation engineers. It would be useless to provide improved and expensive construction for combating decay, and the members of this Association would be barking up the wrong tree in trying to introduce treated lumber into mills when the simple expedient of turning on the heat would do the trick. With these things in mind, the writer set out to test the resistance of certain fungi within wood to varying degrees of heat.

The fungi tested were five found commonly in mills—*Lenzites sepiaria, Lenzites trabea, Trametes serialis, Lentinus lepideus, Trametes carnea.* The first four of these are found doing considerable damage to the roofs of weave sheds, dye houses, paper mills, canning factories, mushroom beds, etc. The reason for giving the names of these plants is this:—there are many different kinds of plants which destroy wood and these five form one group quite widely different from other groups. This group grows where it is warm and moist and may be called the "mill roof" or "damp rot" group. Another group of fungi called the "dry rot" group, including the destructive *Merulius lacrymans* and *Coniophora cerebella*, are the plants which decay houses, cellar timbers, floorings, etc., so rapidly and completely. The name "dry rot" is popularly applied to all wood decay, but all decay is not the same. These two groups differ in manner of living, requirements of moisture and heat and in many other ways. For instance, the "mill roof" group will grow best at a temperature at which the "dry rot" group will not grow at all. Hence, it is readily seen that in tests of the effect of heat upon the plants, like the present one, there must be a definite understanding as to which group we are talking about. Hoxie's experiment dealt with the low temperature "dry rot" group. His results do not apply at all to the "mill roof" group. These experiments of the writer's have to do with the high temperature fungi which grow upon mill roofs. The difference in the application of the results upon the two groups of fungi must be apparent.

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[1] Hoxie, F. J. Dry rot in factory timbers. 2nd Ed. 107 pp. 70 figs. 1915. Inspection department, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

The tests were made upon ¾-inch blocks which were thoroughly grown through with the respective fungi. The blocks were tested at various degrees of heat in both dry and moist atmospheres—the latter suspended over water in a sealed fruit jar and the former free in the drying oven. After the removal of the heated blocks from the oven, cultures upon agar were made in the ordinary way to give the fungous mycelium in the blocks a chance to grow if it was living. If growth occurred on the agar, it showed that the fungus had not been killed, and if no growth occurred in a month, it showed that the heat had been sufficient to kill the fungus.

The minimum killing points for the five fungi at the various temperatures are shown in the graph in figure 1. The various points in the graph mean that at that particular degree of heat for that particular period, the mycelium of the wood destroying fungus was killed, and that for all other periods at that temperature up to that point, there was growth in the test tubes showing that the fungus had not been killed.

It will be noticed that there is quite a difference in the reaction of the wood destroying fungi to moist and dry heat—that the former is much more effective in killing the plants. A difference was to be expected, but not such a wide one. None of the fungi within these blocks were able to withstand 131° F. for 12 hours at moist heat, while it took a heat of 221° F. for 12 hours to kill all the fungi with dry heat. At 212° F., the boiling point of water, one fungus survived 12 hours and another survived 24 hours exposure to dry heat. At 140° F., dry heat, it took 15 days exposure to kill the most resistant of the five plants.

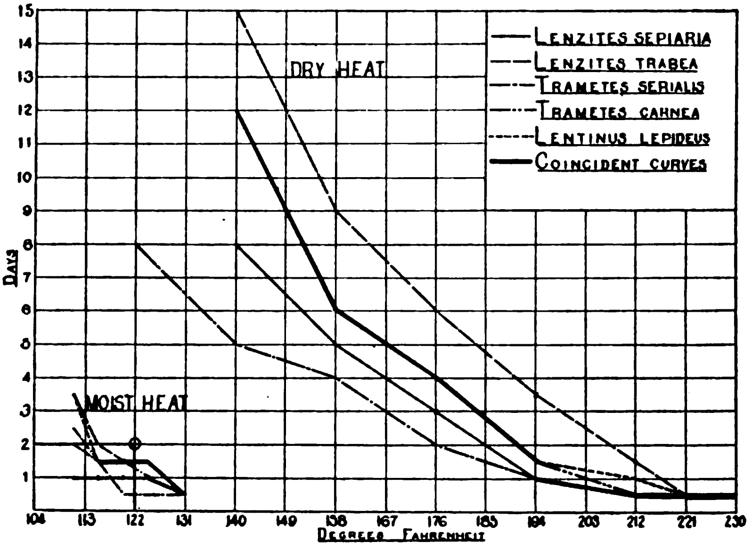

Figure 1. Graph showing the killing points of the mycelium of five "mill roof" fungi within ¾"x¾"x1" spruce blocks, by both moist and dry heat. The circle at 2 days—122° represents the maximum amount of heat theoretically available in a mill over the week-end shut-down. The curve for *Lenzites trabea* dry heat is only tentative in part. The times for certain of the lower temperatures have been found to be too low since the curve was made.

It has been noted that these experiments were carried out on blocks ¾ inch in cross section. Hence, these results will apply very well to 1-inch stock, because the difference in time of heating through a 1-inch block would be very little different from that for a ¾-inch block. And besides, 1-inch stock is usually planed down to ⅞ inch anyway. It is further to be understood that the times and degrees of heat used here would probably have to be greater for thicker stock, like roof planks, although how much greater is not known. Hence, if the amount of heat necessary to kill the fungi in these small blocks is quite high, it will surely take more heat for longer periods to kill any fungi in mills where larger timbers and planks are used.

But even without this consideration in mind and looking only at the graph which is in terms of ¾-inch stock, we are forced to the following conclusions:

1. The use of dry heat in buildings infected with any of the "mill roof" group of fungi is out of the question. Too high a degree of heat for too long a period would be necessary to kill the plants within the wood. A heating system could not supply a heat much above 125° F. and this would accomplish nothing in a partially decayed roof.

2. The application of heat in a structure of moist occupancy would essentially be moist heat, because the air within the wood would be moist with water taken up from the air by the wood. But even on the basis of 1-inch stock, such moist heat as would be available would not accomplish the purpose. If all the heat applied could be made effective for several days, there might be some question of accomplishing the end desired, as seen from the graph, for 2 days' exposure to 122° F. moist heat killed all the fungi. But this is out of the question. It would probably take more heat to kill the plants in the thicker stock, but at any rate, the heat applied could not be conserved. A great deal of it would be conducted away through the walls and roof of a weave shed and it would be impossible to heat a roof to that degree all the way through.

3. Dry heat applied occasionally for the purpose of drying out the wood of a structure is to be recommended. Much timber enters a building partially green, or in a wet condition, after seasoning, and such timbers are very likely to decay. A thorough drying before occupation would prevent immediate decay. A preliminary drying before the application of paint would be good insurance against decay, for paint holds the moisture in and allows decay to set in before thorough drying takes place. For buildings already slowly decaying, a periodic application of heat for as long and as high a degree as possible would retard destruction.

4. In the kiln drying of lumber, these results point out that such a process should be good insurance against decay. Nearly all decay in buildings probably has its inception at some time prior to installation. A great deal of it no doubt starts during the period when it is still green or moist and during the seasoning process. The process of kiln drying lumber should obviate a great deal of this. A comparison of the graph presented here with the heat curves of any run in a dry kiln will show that in most cases sufficient heat is applied to the wood to kill all wood destroying fungi which may have got into the wood up to that time.

5. The same conclusion will apply with equal force to certain wood preservation processes. The heat applied in preliminary steam seasoning and in various treatments, such as the hot and

cold dip, is in most cases sufficient to kill any fungi within the wood.

It is thus seen that the application of heat in buildings infected with the "mill roof" group of fungi will not accomplish any sterilization and at best will only temporarily check any decaying going on. There is a greater possibility of its use with the "dry rot" group because the fungi of that group are more sensitive to heat. Experiments along this line are being carried on. But even if it is found that heat can be used successfully against the true "dry rot" fungi, there is little likelihood that such a discovery would effect the wood preservers' field for marketing treated stock for all structures. In mills where the "mill roof" fungi grow, heat is not practicable. In other structures where the "dry rot" fungi hold forth, such as cellars, etc., heat is not available, and treated lumber is the best insurance against decay even if it were.

THE PRESIDENT: Gentlemen, this paper is now open for discussion.

MR. HUMPHREY: Dr. Snell has a very interesting paper. He has opened up a very important line of thought in connection with the conservation of building timbers. This method of conservation, however, is bound to be merely an adjunct of preservation, as far as I can see it. In very few instances is it going to take the place of wood-preservative treatment. As Dr. Snell has brought out in his paper, the only practical test that we have run on the use of heat in a building is that of Mr. Hoxie to control the growth of the true dry-rot fungus, which is a low-temperature organism and of course the most susceptible to treatment of this sort. We should have some actual tests on this method against other organisms.

I do not wish to criticise Dr. Snell's paper in any way. He has presented very interesting data, and all I want to do is merely to make some suggestions. These tests are all on a laboratory scale, and I do not believe that we are justified in carrying the argument over too far into commercial practice until we have tested the method out commercially. The tests, as you have seen, were conducted on blocks ¾ by ¾ by 1½ inches long, and the blocks were placed in an oven, where they were subjected to heat uniformly on all surfaces.

In the case of a mill roof you cannot get an equal temperature around the timbers, and then again you are up against the problem of having timbers of various sizes, and the heat conduction there is a very great factor. Embedding timber in concrete or in brick walls is another factor of extreme importance, more or less nullifying this method of treatment.

Dr. Snell has shown by graphs that it takes from a day to a day and a half to kill four of the fungi at 194 degrees Fahrenheit, and you can see that this method probably cannot be used in buildings infected with the group of fungi of which he speaks. I agree with him perfectly on this point. The point made in paragraph one, on page four, is all right, with certain qualifications and those qualifications have been brought out very well in paragraph three, so taking the two together I think we have a safe statement to follow.

In connection with the statement that the processes of kiln drying lumber should obviate a great deal of this decay, this is probably correct. Mr. Hubert of our laboratory has been running a number of tests at Madison which brings this out very well. I think we are safe in saying that ordinary, good kiln-drying will eliminate the fungus in the wood.

However, I would take exception to the statement that hot or cold dips of preservatives will kill fungi in wood. I think that is a very dangerous statement to make. I am sure no wood preserver would attempt to state that a brush treatment of timber which is infected with fungi would be at all efficacious.

THE PRESIDENT: In paragraph 3, Mr. Snell brings out a point you all may not have caught. It is that "paint holds the moisture in and allows decay to set in before thorough drying takes place." The usual painting creates conditions that favor decay, and that point should be well noted. Mr. Humphrey states that the hot and cold dips would not be sufficient to kill fungi in wood, but I think we have to realize that Professor Snell was working on thin strips. No one should go away with the thought that by hot and cold dipping we can keep the rot out of ties, because no such thing is possible. Mr. Hoxie has sent in a written discussion, which the Secretary will read.

The Secretary then read Mr. Hoxie's discussion as follows:

Discussion by Mr. F. J. Hoxie.

Dr. Snell's paper entitled "The Effect of Heat on Wood-Destroying Fungi in Mills" and mentioning my experiments on the practical use of heat in new buildings does not quite give the idea which I intended to convey in regard to the use of the heating system for eliminating fungus destruction in new buildings. I did not intend to advocate the use of the factory heating system to take the place of intelligently selected and treated lumber.

I agree with Dr. Snell that there are two groups of fungi conspicuous in the destruction of structural timber. One of these groups represented by the *Lenzites* family can tolerate high temperature, nearly or quite up to the boiling point of water as shown by Dr. Snell. This group is most active in the destruction of the roofs of weaving factories and paper machine buildings in which the moisture and temperature are always high. The other group represented by the true dry rot or lachrymans fungus thrive in a moist, cool atmosphere and can be killed at a comparatively low temperature, according to the observations of Richard Falk in Germany and of Dr. Snell; my own experiment which was less scientifically conducted than those of the above mentioned gentlemen, dealt with the broad problem of the rapid rotting of the entire frame of a large factory building.

This dry rot group of fungi is responsible for the most spectacular cases of rapid destruction of new buildings both in America and Europe. The living fungus is practically always brought into the building in the lumber in which it has become deeply installed in the cool moist conditions of the lumber yard. If the timbers are of large cross section such as are commonly used for the frame of slow burning buildings it will take a long time for them to dry out at the common conditions of temperature and moisture of a factory building. The wetness of the beams will improve their heat conductivity, as well as facilitate the destruction of the fungi by providing the moisture shown by Dr. Snell to encourage the killing of the fungi at much lower temperatures than it could be accomplished under dryer conditions.

In the vast majority of dry factory buildings with the lumber installed in a sound condition and free from living fungi no apprehension need be entertained for subsequent rotting as no variety of fungus can be propagated under the dry conditions commonly prevailing. The dry rot group of fungi practically never attack such buildings after they are once completed and in use. This makes it particularly necessary to kill this dangerous and quick-growing group of wood destroyers in a new structure at the earliest possible moment. It is hardly worth while to go to the trouble and expense of chemical treatment of these large timbers which, owing to their large size, are particularly difficult to give thorough treatment if the only advantage to be gained is to destroy this group of fungi which can be much more cheaply and conveniently destroyed by the building heating system.

It will doubtless be worth while to give a simple chemical treatment to all structural timber as soon as possible after it leaves the saw to prevent it from being attacked by fungi in transit or in the lumber yard. This will doubtless become the universal practice in the not distant future. Thus far, however, the problem that presents itself is the prevention of the rapid destruction of heavy timber which may be and generally is infected by several kinds of fungus when it is received from the lumber yard.

The numerous cases in which factories have shown serious deterioration within two years has made owners and engineers cautious and also made them willing to make a reasonable expenditure to prevent the possibility, even though it be somewhat remote, of later serious destruction It has also encouraged the use of concrete due to this mysterious and apparently uncontrollable rapid rotting of new buildings.

I do not recommend heating as a universal and final remedy for all fungus troubles, but rather as a cheap and convenient means of limiting this most treacherous source of loss from the dry rot group of fungi until such time as the intelligent use of properly preserved lumber becomes sufficiently general to render it unnecessary.

MR. HUMPHREY: Mr. President, may I offer comment on this?

THE PRESIDENT: Surely.

MR. HUMPHREY: I am glad to see Mr. Hoxie emphasize so clearly the necessity of discriminating in practice between the dry rot group of fungi, as typified by *Merulius lachrymans*, and the group of high-temperature organisms represented by *Lenzites sepiaria*. This is the first point to consider in recommending heat applications in buildings. However, even though heat may not kill, it is certainly one of the most feasible things we have as a prophylactic measure in controlling the development of rot in buildings. If you put green timber or partially seasoned timber in a building, and it does not have the opportunity to dry out under an artificial heating system or by natural ventilation you are bound to have trouble with that timber. If you can arrange your heating system so that you can add heat to the atmosphere surrounding the wood, you are going a long way toward controlling outbreaks of rot. Even with infected timber you can do much toward stopping the growth of the fungi by the application of heat close to the wood, and in that way heat is a valuable adjunct in the control of these troubles.

THE PRESIDENT: Anyone interested in the problem of heat transmission in wood can get valuable data from a report that was presented to this Association by our Secretary, Mr. Hunt, in 1915, which showed how slowly heat permeates timber.

A recess was then taken until two o'clock P. M.

TUESDAY AFTERNOON SESSION

January 24, 1922

The meeting was called to order by the President, Mr. Taylor, at two o'clock P. M.

THE PRESIDENT: We will have the report of the Committee No. 4, on Preservatives.

DR. KAMMERER: Mr. President and Gentlemen, I will not read the report in detail. I shall read only those portions that are necessary to read for a complete understanding, and will refer to the others briefly, giving the page citation. I assume all of you have copies of the report before you.

REPORT OF COMMITTEE NO. 4—PRESERVATIVES

To the Members of the American Wood-Preservers' Association:

The original instructions of the Executive Committee to this Committee were as follows:

> Accumulate data on actual experience with joint committee method for sampling cars of oil for water, and if the experience is favorable, recommend that the method be adopted as a standard.
>
> Compile information on vertical retort tar.

To these original instructions the following were added later:

> Work out specifications for preservative to be used on non-pressure treatments.
>
> Develop information in regard to "blast furnace tar creosote oil."

In addition to the subjects included in the above instructions the Committee on its own initiative added the following:

> A review of the Committee's zinc chloride report of last year, including a check of the data presented and a practical test of the tentative methods for zinc chloride analysis.
>
> The advisability of revising the present creosote-coal tar specification so that it will specify physical qualities rather than percentage limits of oil and tar allowed, as at present.

Three meetings of the whole Committee were held during the year, one at Chicago on March 15 and two at Cleveland on July 1 and Oct. 7, with the following attendance: March 15 meeting, 4 members present; July 1 meeting, 6 members, including the president, ex-officio member of the Committee; Oct. 7 meeting, 6 members present.

As heretofore the detailed work of the Committee was done by means of small sub-committees. The chairman appointed sub-committees for the various subjects as follows:

Car Sampling: S. R. Church, representing the A. W. P. A. on joint committee.

Oil Derived from Vertical Retort, Blast Furnace and Low Temperature Coal Tars and Similar Products:
Ernest Bateman, Chairman.
W. H. Fulweiler.
F. W. Kroemer.

Zinc Chloride: L C. Drefahl, Chairman.
F. G. Breyer.
Revision of Creosote—Coal Tar Solution Specification:
S. R. Church, Chairman.
J. H. Gibboney.
K. N. Waddell.
Galen Wood.
Specifications for Creosote Oil for Non-Pressure Treatments:
S. R. Church, in co-operation with Roger F. Hosford, Chairman of Committee E-5, Pole Treatment, and Kurt C. Barth, Chairman of Committee 7-01, Economics.

I. Joint Committee on Sampling Creosote Oil in Tank Cars For Water Determination

In the report of our Committee at the 1921 meeting the following recommendation appears under subject 4: "It is recommended that the Committee for next year be instructed to continue the work on this subject and to definitely report the advisability of adopting this method of sampling tank cars as a standard." At the meeting in Cleveland on Oct. 7 the Committee voted that the present scheme of sampling be recommended for adoption as standard without further attempts to test it in the field, as all attempts in this direction had proved a failure, with the exception of favorable reports by two railroads. The Committee further voted that an alternative apparatus be designated which could be used as a substitute for the standard sampling device in case of emergency.

The report of the Joint Committee on Sampling follows:

In accordance with instructions from the Committee on Preservatives, American Wood-Preservers' Association, the Joint Committee representing the American Wood-Preservers' Association, the American Railway Engineering Association, and the American Society for Testing Materials, now presents for adoption as standard the method previously described and illustrated. (Proceedings, 1920, pages 33-38 incl.) It is also recommended that the example given at the top of page 39 be reprinted along with the standard method of making these calculations. In accordance with suggestions adopted by the Committee on Preservatives, American Wood-Preservers' Association, we also present as a footnote, to be related to the paragraph marked "Sampling Device" or to be printed immediately following same, this text:

> "As an alternative to the standard sampling device, it is permissible to use a wide mouthed vessel attached to a graduated wooden or metal rod, and fitted with a tight cork or stopper that can be withdrawn by a cord or light chain when the vessel is lowered to the specified levels. The sampling operation shall be conducted exactly as described, but great care must be taken in lifting the rod so as not to disturb the contents of the sampler. This device is not recommended for general use but may be used when a standard sampler is not obtainable." (See fig. 1.)

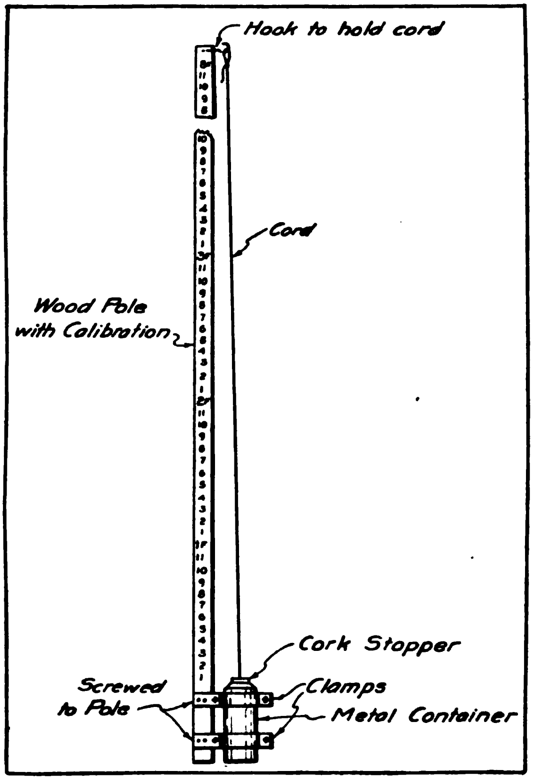

FIG. 1. Alternative sampling device. A. W. P. A. Committee on Preservatives.

II. Oils Derived from Vertical Retort, Blast Furnace, and Low Temperature Coal Tars and Similar Products

The Committee was specifically instructed to continue work on vertical retort tar oils and to develop information on blast furnace oil. A study of low temperature coal tar oils was added on account of its close relation to the above oils. Recently an interesting oil derived from high temperature petroleum gas tar was brought to the Committee's attention. This oil was therefore also included in its study.

Vertical Retort Tar Oils

The Committee last year reported rather fully on this material. During the last year there has been produced in this country 9,500,000 gallons of vertical retort tar. As stated last year, the oils obtained from vertical retort tar are intermediate between those obtained from blast furnace tar and high-temperature coal tar. In general, the tar acid content and the amount of unsulphonated residue are usually higher than is found in coal tar creosote, but not so high as in blast furnace oils. The specific gravities of the vertical retort tar oils and of the individual fractions derived therefrom are generally lower than those of coal tar creosote but are higher than those of blast furnace oils. The naphthalene content of vertical retort tar is much less than is usually found in high-temperature coal tar. As stated last year, service tests are being carried on by the Forest Products Laboratory in co-operation with the Chicago, Milwaukee and St. Paul Railroad and the United Gas Improvement Company with oil obtained from vertical retort tar. Analyses of oils from this class of tar are given in table 1.

Low Temperature Coal Tar Oils

A recent development in the distillation of coal is a two-stage process in which bituminous coal is first distilled at a comparatively low temperature, driving off the greater part of the volatile matter, and is then briquetted and heated to a high temperature to produce a high grade smokeless fuel. During the first stage of this operation a considerable amount of tar is given off and collected. This tar forms the basis of a tar oil which might in the future be of considerable consequence in wood preservation. A yield of about 30 gallons of tar per ton of coal carbonized is obtained by this process, yielding in turn 8 to 12 gallons of oil. The manufacturers state that at present the production is in the neighborhood of 1,000,000 gallons of oil per year. Analyses of oils obtained from this class of tar are given in table 1.

The Committee understands that the Forest Products Laboratory has treated 200 ties with this oil and mixures of this oil and tar and has placed them in their test track.

Blast Furnace Tar Oil.

No true blast furnace tar is made in this country at the present time because practically all of our blast furnaces use either charcoal or coke for fuel, which materials do not produce tar. Blast furnaces using raw coal as fuel are operated in Scotland, England, Germany and Russia. In general, the coal used in a blast furnace is a bituminous coal of the non-caking type and contains in the neighborhood of 40 per cent volatile matter. Scotland seems to be the only country at the present time working up this tar into oil.

Blast furnace oil has been used in both England and Scotland to some extent, but your Committee has not been able to obtain any records of its service except those found in the United States Forest Service Circular 98 by Gellert Allerman. This circular contains a record of two ties of the London and Northwestern Railway Company which were in good condition after nineteen years' service. That blast furnace oil is recognized as a wood preservative oil in England is shown by the modification which follows the standard specification 144 (1921) of the British Engineering Standards Association for creosote for railway sleepers and telegraph, telephone and hangar poles. This provision for both Scotch creosote and blast furnace oil is as follows:

Scotch creosote shall conform to the above specification (creosote oil)[1] with the following exceptions: The specific gravity shall be not less than 1 at 38° C. (100° F.). In the case of the blast furnace oil the specific gravity may be lower, but shall not be less than 0.940 at 38° C. (100° F.). The distillate at 315° C. (599° F.) shall be not more than 85 cc. and the residue not less than 15 grams. There shall be no upper limit to the amount of tar acids.

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[1] The British standard specification (No. 144) for creosote for railway sleepers, and telegraph, telephone and hangar poles as given in Colliery Guardian, CXXII, Oct. 7, 1921, p. 1001, is as follows: "The specific gravity shall be not less than 1.015 and not more than 1.07 at 38° C. (100° F.) when compared with water at the same temperature. The material shall become completely liquid on being slowly warmed to 38° C. (100° F.) with stirring, and on cooling down shall remain completely liquid after standing for two hours at 32° C. (90° F.) The amount of water in the creosote shall not exceed 3 per cent. When 100 cc. measured at 38° C. (100° F.) of the dry creosote are distilled from a 250 cc. distillation flask at such a rate that the distillation is complete in about 20 minutes, there shall distill at 760 mm. pressure,
up to 205° C. (401° F.) not more than 7 cc.,
up to 230° C. (446° F.) not more than 40 cc.,
up to 315° C. (599° F.) not more than 78 cc.,
the volumes of all fractions being measured at 38° C. (100° F.)

The residue above 315° C. (599° F.) shall be soft and not sticky and its weight shall be not less than 22 grams.

The amount of tar acids shall be not less than 5 per cent, and not more than 16 per cent by volume.

The amount of matter insoluble in benzol (benzene) shall not exceed 0.4 per cent by weight.

The Committee has been unable to obtain any record of blast furnace oil being imported into this country for wood preservation although there has been imported from 250,000 to 500,000 gallons a year for use in disinfectants, cattle dips, etc.

An analysis of blast furnace oil is given in table 1.

The Committee wishes to point out that the vertical retort tar oils, the low-temperature coal-tar oils and blast-furnace oils are all obtained from tars derived from coal but produced at temperatures somewhat lower than those obtaining in coke-ovens producing coke-oven tar. The low-temperature coal-tar oils and the blast-furnace oil, as might be expected from their manner of production, have somewhat the same general characteristics. Their gravities are both low being in the neighborhood of that of water. They both contain large amounts of tar acids and considerable amounts of unsulphonated residue. The vertical retort tar oils, as was stated in a previous paragraph, are intermediate between these oils and the ordinary coal tar creosote, viz., the oil obtained from coke-oven tar and horizontal retort tar.

High Temperature Petroleum Gas Tar Oils

On the Pacific Coast much of the illuminating gas is manufactured in all-oil gas producers. The apparatus consists of two firebrick-lined steel sheets connected at the bottom and filled with checker brick. The manufacture of the gas is carried out in two stages. In the first stage the checker brick is brought to a high temperature by burning oil with a blast of air. In the second stage the air blast is cut off and the main supply of oil is injected with steam. This results in a very complete decomposition of the oil into permanent gases containing only a few per cent of olefinic hydrocarbons, a large quantity of lampblack and only a small amount of tar.

In the carburetted water gas process the oil is decomposed in the presence of a large volume of blue gas. The hydrogen in the blue gas has a considerable influence on the nature and direction of the decomposition, resulting in a gas very high in olefinic hydrocarbons, a mere trace of lampblack and free carbon and 15 to 18 per cent of tar.

TABLE 1. ANALYSES OF VERTICAL RETORT OILS, LOW TEMPERATURE COAL TAR OILS AND BLAST FURNACE OILS.

Sp. Gr. 38/15.5° C. of original oil	Insoluble in benzol	Tar acids	Tar bases	Distillates				Coke residue	Sulphonation residue	Sp. Gr. 38/15.5° C of fraction 235-315°C	Sp. Gr. 38/15.5° C of fraction " 31 -355° C
				Up to 210° C	Up to 235° C	Up to 270° C	Residue above 355° C				
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.		
Vertical retort oils											
.998	.1	14.0	10.0	12.1	27.6	47.8	17.3	1.07	7.6	.99	1.05
1.09	.07	....	....	3.2	3.67	....	48.0	1.7	....	1.024	1.076
1.04	....	....	....	1.9	11.4	....	10.4	....	....	1.031	1.080
1.08	....	....	....	3.2	16.0	....	48.8	....	....	1.025	1.073
1.04	....	....	....	3.9	24.0	....	11.9	....	....	1.023	1.075
1.105	....	....	....	.8	3.55	....	58.4	....	....	1.031	1.073
1.043	....	....	....	3.4	19.4	....	3.3	....	....	1.085	1.093
1.044	....	....	....	11.2	26.7	....	16.2	....	....	1.025	1.091
Low temperature coal tar oils											
.94	....	36.5	4.0	48.3	73.7	88.9	2.4	....	12.4[1]	.99	....
.95	....	29.0	4.0	43.0	65.0	79.7	2.2	....	12.1[1]	1.00	....
.95	....	24.0	5.0	6.0	33.7	73.4	4.8	....	13.0[1]	1.00	....
Blast furnace oils											
.966	....	26.6	1.9	3.3	21.4	50.1	10.0	....	10.0	.953	.982

[1] Average 93 fractions.

TABLE 2. COMPARISON OF REQUIREMENTS OF A PURE COAL TAR CREOSOTE AND ANALYSES OF HIGH TEMPERATURE OIL TAR OILS.

Specific gravity of original oil	Float test	Distillates					Specific gravity of fraction 235-315° C	Specific gravity of fraction 315-355° C
		Up to C Per cent	Up to 235° C Per cent.	Up to 270° C Per cent.	Up to 355° C Per cent.	Residue above 355° C Per cent.		
Required for coal tar creosote								
N. L. T[1] 1.03	N. M. T.[2] 50	N. M. T. 5	N. M. T. 25	....	....	....	N. L. T. 1.03	N. L. T. 1.10
High temperature oil tar oil								
1.12 1.11	18 5	3.5 0	11.2 24.7	26.7	57.3	42.7 54.8	1.060 1.056	1.125 1.094

[1] N. L. T. Not less than
[2] N M. T. Not more than

The tar collected from the all-oil gas producer is a heavy pitchy mass so nearly solid that it can be handled with shovels. A certain amount of it is being distilled, however. The oil resulting from such a distillation is practically a pure hydrocarbon oil containing neither tar acids nor tar bases. The hydrocarbons are almost entirely of the aromatic series. Oils from this source are now on the market as wood preserving oils. Such oils will pass all the requirements of the Association's specification for coal-tar creosote except that they are not obtained from coal tar.

The Committee has no information as to how much of this tar could be made available. It believes, however, that this oil deserves more attention by future committees particularly with a view of distinguishing it from coal-tar creosote as well as to determine its value as a wood preservative.

Analyses of this oil are given in table 2, in comparison with a pure coal-tar creosote.

III. Zinc Chloride

The Sub-Committee on this subject was instructed to revise the zinc chloride portions of the Preservative Committee's report of last year and make what revisions seemed advisable. It was also to submit the tentative methods of analysis to a thorough test and to make recommendations as to their adoption as standard.

The following sections offered as information in last year's report were reviewed and are considered acceptable as they stand:

Basic zinc chloride
Shrinkage of zinc chloride on dilution
Impurities in commercial 50 per cent zinc chloride

Methods of Analysis

(a) Revision of standard volumetric ferricyanide methods of analysis.

(b) Tentative gravimetric method.

(c) Tentative volumetric method for quick routine analysis.

A great deal of work was done on this subject. Four accurate samples of zinc chloride were prepared and submitted to twenty-five interested collaborators. Twenty have up to the present time turned in reports of their work. A list of collaborators follows:

American Creosoting Co.
Baltimore and Ohio Railroad (Two treating plants)
Union Pacific System
Atchison, Topeka and Santa Fe Railway (Two treating plants)

Forest Products Laboratory
Frisco Lines
International Creosoting Co.
Von Schrenk and Kammerer
Monsanto Chemical Co.
Kettle River Co.
New Jersey Zinc Co.
Missouri, Kansas and Texas Railway
Rock Island Lines
Chicago, Burlington and Quincy Railroad
Grasselli Chemical Co.
Port Reading Creosoting Plant
General Chemical Co.
Republic Creosoting Co.

The following samples were submitted for analysis:

1. Zinc Chloride Solution (Commercial) Approximately 50 per cent
2. Zinc Chloride Fused (Commercial) Approximately 94 per cent
3. Zinc Chloride Solution (Commercial) Approximately 5 per cent
4. Zinc Chloride Solution (Commercial) Approximately 3 per cent

A detailed description of the methods of analysis was submitted with the samples. These methods were essentially those recommended as tentative methods at the 1921 Annual Meeting, slightly modified to insure greater definiteness.

A tabulation of the results turned in by the collaborators is given below:

Analyzed by	Chloride of Zinc Solution (Per cent)						Gran. Chloride of Zinc (Per cent)	
	A	B	C	D	E	F	G	H
1	49.96	50.41	4.73	4.74	2.86	2.84	96.90	96.71
2	50.54	50.76	5.02	....	3.02	....	95.50	95.84
3	49.84	50.025	4.875	....	2.965	....	93.78	94.39
4	50.715	50.33	4.84	....	2.92	....	93.97	94.45
5	49.84	50.01	4.70	....	2.75	....	94.76	94.95
6	49.08	50.12	4.85	....	2.91	....	93.69	95.32
7	50.16	50.14	4.87	....	2.96	....	94.87	94.55
8	....	....	4.89	....	2.96	....	....	....
9	50.08	50.94	4.88	....	2.97	....	94.97	95.28
10	50.17	50.20	4.66	....	2.82	....	96.56	96.55
11	50.1	48.47	4.66	....	2.84	....	93.6	91.2
12	50.26	50.34	4.86	4.88	2.97	2.82	95.28	95.27
13	50.09	49.98	4.80	....	2.97	....	94.63	94.41
14	49.40	49.70	4.91	....	2.99	....	94.00	94.70
15	49.64	50.76	4.56	4.86	2.77	2.93	93.87	93.55
16	50.61	50.78	4.78	....	2.85	....	96.07	95.01
17	49.56	49.76	4.83	4.90	2.73	2.94	94.14	93.53
18	49.07	49.16	4.67	....	2.79	....	93.13	93.20
19	50.20	50.13	4.96	....	2.98	....	95.65	95.45
20	50.32	49.83	4.98	....	2.98	....	95.77	96.14

A—Official Volumetric Method—45-55 per cent $ZnCl_2$
B—Tentative Gravimetric Method—45-55 per cent $ZnCl_2$
C—Tentative Volumetric Method—4-6 per cent $ZnCl_2$
D—Tentative Gravimetric Method—per cent $ZnCl_2$
E—Tentative Volumetric Method—1-3 per cent $ZnCl_2$
F—Tentative Gravimetric Method—1-3 per cent $ZnCl_2$
G—Official Volumetric
H—Tentative Gravimetric

After a careful study of the foregoing results and a careful consideration of the criticisms and the comments of the collaborators, the Committee was led to the following conclusions and recommendations:

Standard Method of Volumetric Analysis

On the whole the results with this method are satisfactory. (See columns A and G in above table.) There should, however, have been closer agreement. The Committee feels certain that the lack of closer agreement is not due to any imperfection in the method, but rather to inexperience and to the lack of the equipment (chemicals and apparatus) called for in the method. Probably the greatest discrepancies have come about because of not having high grade zinc on hand of known tested purity. The ordinary chemically pure zinc of commerce varies greatly and is far from pure. It has come to the notice of the Committee that some collaborators used such material. Others tried to prepare pure zinc chloride, while still others used C. P. (so-called) zinc oxide for a standard.

The Committee strongly recommends that the details of the official volumetric method be literally followed and wishes to emphasize the importance of using high grade zinc (U. S. Bureau of Standards)* exclusively for standardization. If this precaution is taken satisfactory results will be obtained. The Committee recommends no changes in the official volmetric method.

Tentative Gravimetric Method

The results obtained with the tentative gravimetric zinc phosphate method are not as satisfactory as would seem desirable. (See preceding table, columns B, D, F, and H.) This method is open to some objections. Its success depends on a very close regulation of acidity. A further objection to it is the co-precipitation of associated materials, lime, magnesia, etc., occurring as minor impurities in commercial zinc chloride.

The Committee believes that this method should be retained as a tentative gravimetric method until a more satisfactory one has been developed, and recommends that the Preservative Committee for next year be instructed to work up a new gravimetric method for the accurate analysis of zinc chloride, submitting same to commercial laboratories for trial before presenting it to the Association.

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* This material may be obtained from the New Jersey Zinc Co.

The gravimetric zinc phosphate method as sent to the collaborators was somewhat amplified for the sake of clearness. The method as sent out was as follows:

Tentative Gravimetric Method for the Analysis of Zinc Chloride

INSOLUBLE (BASIC ZINC CHLORIDE). Ten to fourteen grams of the sample (fused or granulated) or an equivalent quantity of solution, are weighed from stoppered weighing bottles into a 600 cc. pyrex or equivalent beaker. Four hundred cubic centimeters of cold water are added and stirred until the material is completely in solution.

The basic zinc chloride is allowed to settle over night. The solution is filtered through a weighed filter paper (12½ cm). The filtrate is received in a graduated calibrated measuring flask, capacity 1000 cc. The beaker is policemanned and the insoluble matter on the filter paper is washed thoroughly until the filtrate measures 1 liter. The filter paper containing the insoluble matter is dried over night in a bath heated to 212° F., cooled, and weighed between clipped watch glasses. Increase in weight is calculated to insoluble (basic) matter. It is necessary to previously wash and dry the 12½-cm. paper used for filtering the insoluble matter, in order that this paper gets treatment analogous to that used in actual analysis. A Gooch crucible may be subsituted for the weighed filter paper.

Owing to the fact that the hydrated oxychloride of zinc is slightly soluble in water, it becomes necessary to make the method empirical, and in order to get concordance between various operators it is necessary to pass all the water necessary to make up the liter through the filter containing the precipitate.

ESTIMATION OF ZINC. The filtrate from the insoluble matter referred to previously is made up to the mark and shaken. Three aliquot portions of 100 cc. each are taken with 100-cc. pipette which has been accurately calibrated volumetrically against the flask used for receiving the filtrate. Add sufficient bromine water to impart a strong reddish brown color to the solution and boil until all the bromine has been expelled. Add approximately 5 cc. of saturated solution of ammonium chloride for each 1/10 gram of zinc present. Make the solution strongly ammoniacal and filter off the iron and the manganese. 15 cc. of C. P. ammonia is recommended. Wash the precipitate with wash water (10 cc. conc. ammonia, 10 grams ammonium chloride in 1 liter of water). Boil the filtrate until the solution no longer smells of ammonia. Add 1 drop of methyl red indicator. Add 10 cc. saturated solution of ammonium phosphate for each 1/10 gram zinc present. Just neutralize the solution with acetic acid and add 1 cc. acetic acid in excess. Heat the solution on a steam bath for a few minutes until the flocculent precipitate of zinc ammonium phosphate has become crystalline and cool to room temperature. Transfer the precipitate to a previously ignited and weighed Gooch crucible and wash the precipitate 3 or 4 times with hot water. Heat the crucible to a cherry red for 10 minutes, cool, and weigh the zinc pyrophosphate.

The following alternative method is permissible in case trouble is experienced getting suitable asbestos. Collect the zinc ammonium phosphate on a double ashless 11 cm. filter paper, using an ordinary funnel. Wash same thoroughly as outlined above and dry at 100° C. The precipitate is then carefully separated from the filter paper on a glazed paper and covered with a watch glass and the filter paper is incinerated in a weighed porcelain crucible. The crucible is removed from the muffle, cooled and the balance of the separated precipitate added. The incineration is then carried on as recommended when a Gooch crucible is used. The weight of the zinc pyrophosphate $Zn_2P_2O_7$ (molecular weight 304.8), multiplied by 0.894 gives the equivalent weight of zinc chloride, or the weight of pyrophosphate multiplied by 0.429 gives the equivalent weight of zinc. (Report per cent $ZnCl_2$.)

PREPARATION OF GOOCH CRUCIBLE. A Gooch crucible of suitable size may be used for this determination. A convenient size is approximately 1⅜ inches in diameter, 1½ inches deep. The perforated bottom of the crucible is covered with 1 or 2 layers of ashless filter paper, cut to suitable size. Long fiber asbestos, treated in the usual manner for removing the soluble constituents, thoroughly washed and maintained as a slurry is poured into the Gooch crucible until a pad of suitable thickness has been formed. The pad is thoroughly washed and ignited from 10 to 15 minutes at a good red heat. The crucible is then cooled in a dessicator to room temperature and weighed.

Tentative Volumetric Method for the Rapid Routine Analysis of Dilute Zinc Chloride Solutions

This method was proposed as an alternative for the indirect chloride method for the estimation of zinc in weak solutions of zinc chloride for plant operation purposes. Commercial zinc chloride contains small amounts of associated chlorides, which, if estimated by the indirect chlorine method, are calculated to equivalent per cent zinc chloride.

The results obtained by the collaborators were quite satisfactory. (See the foregoing table, columns C and E.) In view of the results and comments obtained, the Committee feels warranted in recommending this method as an official volumetric method for the rapid estimation of zinc chloride plant-working solutions. The method is as follows:

CHEMICALS AND APPARATUS:

Distilled water
1/10 standard hyposulphite of soda solution
5 per cent soluble starch solution
10 per cent potassium iodide solution
10 per cent potassium ferricyanide solution
C. P. sodium hydroxide
C. P. zinc (electrolytic or equal) 99.96 per cent or better
Beaker or other receptacle capable of holding 400 cc.
Glass rod
2 Mohr burettes, 50 cc. capacity
25-cc graduate
10-cc pipette
1 liter measuring flask against which 1 Mohr burette, capacity 50 cc, has been calibrated
500 cc. graduate
1.00 to 1.06 hydrometer
Hydrometer jar.

PREPARATION OF STARCH SOLUTION. Weigh 5 grams soluble starch into 250-cc. beaker, make into a thin paste with a small amount of cold water. Pour into 100 cc. boiling water, stirring during addition of the starch. Bring to a boil and then cool. Pour into a suitable bottle for future use. This solution is perishable and should be made up at least every 3 days.

PREPARATION OF STANDARD ZINC CHLORIDE. Weigh 5.7580 grams U. S. Bureau of Standards zinc (See note on page 43) into a covered 400-cc. beaker. Add 25 cc. 1:1 hydrochloric acid. When solution of zinc is complete evaporate to dryness on steam bath. Take up in 300 cc. water and transfer same to 1000-cc. measuring flask. Wash beaker thoroughly. Add 2 drops of mythyl orange indicator (0.1 gm. in 100-cc. water), bring to exact neutrality with a dilute solution of C. P. sodium hydroxide (1/10 normal). If the endpoint is slightly overrun, bring back to exact neutrality with a few drops of dilute hydrochloric acid. Make up to the mark in a flask with water and thoroughly mix.

PREPARATION AND STANDARDIZATION OF 1/10 NORMAL SODIUM HYPOSULPHITE SOLUTION. Weigh out 24.82 grams of crystallized, highest purity sodium hyposulphite. Dissolve in water and make up to 1000 cc.

Withdraw aliquot portions of 25 cc. each of the standard zinc chloride solution with the aid of a 50-cc. Mohr burette which has been calibrated to the flask and introduce into a beaker or other suitable receptacle of 400 cc. capacity. Titrate with the sodium hyposulphite solution as described below under method of analysis. The 25-cc. aliquot portions of the zinc chloride solution contains 0.3 grams $ZnCl_2$ each. 0.3 grams $ZnCl_2$ divided by the number of cc. of the sodium hyposulphite solution consumed equals the value of 1 cc. of hypo in terms of zinc chloride. 1 cc. exact N/10 hyposulphite solution equals 0.0215 grams zinc chloride.

METHOD OF ANALYSIS. This method is intended for solutions containing up to 5 per cent zinc chloride. The solution to be tested must be neutral. Free acid must be avoided. Take the specific gravity of the solution to be tested with suitable hydrometer. Pipette 10 cc. of the zinc chloride solution into a beaker or other receptacle holding 400 cc. The foregoing procedure is suggested for those plants having no laboratories. For plants having laboratories and an analytical balance it is preferable to weigh 10 cc. in a weighing bottle. To the solution in the beaker add 10 cc. water, 20 cc. potassium ferricyanide solution, and 10 cc. of potassium iodide solution. Stir for 2 minutes. Add 100 cc. of cold distilled water, then about 2 cc. of starch. Titrate with 1/10 normal sodium hyposulphite solution until blue fades to lemon yellow. Two drops will accomplish this end. With much iron present a light greenish cast remains after the blue has faded, due to the presence of a small amount of prussian blue. A little practice will accustom the eye to the endpoint, which is sharp.

CALCULATION. The number of cc. N/10 sodium hyposulphite solution taken times its $ZnCl_2$ equivalent (see above) times 100 divided by the weight of zinc chloride solution taken (balance weight), or the weight arrived at by multiplying the 10 cc. of sample taken by the specific gravity (hydrometer determination), equals percentage of zinc chloride.

Sampling Zinc Chloride

The Committee has nothing to add to the 1921 report with reference to this subject. The methods recommended are believed to be as satisfactory as can be devised for this material.

Specific Gravity Table

The specific gravity table for zinc chloride (0 to 70 per cent) presented last year has been carefully reviewed with the result that several slight changes have been made. The table as now presented is believed to be accurate to a high degree. It might be well to again call attention to the fact that this table is based on chemically pure zinc chloride. The gravity figures given in this table will be somewhat lower than the gravities of solutions of commercial zinc chloride of corresponding strength (soluble zinc chloride). This table is recommended for inclusion in the Manual.

PROPERTIES OF ZINC CHLORIDE SOLUTION AT 60 DEGREES F.

Bé°	Sp. Gr.	$ZnCl_2$ Per cent	Weight of 1 cu. ft. Pounds	$ZnCl_2$ in 1 cu. ft. Pounds	50 per cent $ZnCl_2$ Per cent	50 per cent $ZnCl_2$ in 1 cu. ft. Pounds
0	1.0000	0.00	62.37	0.0000	0.00	0.0000
1	1.0069	0.76	62.80	0.4773	1.52	0.9546
2	1.0140	1.53	63.24	0.9676	3.06	1.9352
3	1.0211	2.29	63.69	1.4585	4.58	2.9170
4	1.0284	3.05	64.14	1.9563	6.10	3.9126
5	1.0357	3.81	64.60	2.4613	7.62	4.9226
6	1.0432	4.63	65.06	3.0123	9.26	6.0246
7	1.0507	5.45	65.53	3.5714	10.90	7.1428
8	1.0584	6.27	66.01	4.1388	12.54	8.2776
9	1.0662	7.09	66.50	4.7149	14.18	9.4298
10	1.0741	7.91	66.99	5.2989	15.82	10.5978
11	1.0821	8.78	67.49	5.9256	17.56	11.8512
12	1.0902	9.65	68.00	6.5620	19.30	13.1240
13	1.0985	10.52	68.51	7.2073	21.04	14.4146
14	1.1069	11.39	69.04	7.8637	22.78	15.7274
15	1.1154	12.26	69.57	8.5293	24.52	17.0586
16	1.1240	13.21	70.10	9.2602	26.42	18.5204
17	1.1328	14.15	70.65	9.9970	28.30	19.9940
18	1.1417	15.10	71.21	10.7527	30.20	21.5054
19	1.1508	16.04	71.78	11.5135	32.08	23.0270
20	1.1600	16.98	72.35	12.2850	33.96	24.5700
21	1.1694	17.96	72.94	13.1000	35.92	26.2000
22	1.1789	18.94	73.53	13.9266	37.88	27.8532
23	1.1885	19.92	74.13	14.7667	39.84	29.5334
24	1.1983	20.90	74.74	15.6207	41.80	31.2414
25	1.2083	21.88	75.36	16.4888	43.76	32.9776
26	1.2185	22.88	76.00	17.3888	45.76	34.7776
27	1.2288	23.88	76.64	18.3016	47.76	36.6032
28	1.2393	24.89	77.30	19.2400	49.78	38.4800
29	1.2500	25.89	77.96	20.1838	51.78	40.3676
30	1.2609	26.90	78.64	21.1542	53.80	42.3084
31	1.2719	27.91	79.33	22.1410	55.82	44.2820
32	1.2832	28.91	80.03	23.1367	57.82	46.2734
33	1.2946	29.92	80.74	24.1574	59.84	48.3148
34	1.3063	30.93	81.47	25.1987	61.86	50.3974
35	1.3182	31.93	82.22	26.2528	63.86	52.5056
36	1.3303	32.94	82.97	27.3303	65.88	54.6606
37	1.3426	33.95	83.74	28.4297	67.90	56.8594
38	1.3551	34.96	84.52	29.5482	69.92	59.0964
39	1.3679	35.97	85.33	30.6896	71.94	61.3792
40	1.3810	36.98	86.13	31.8509	73.96	63.7018
41	1.3942	38.02	86.96	33.0022	76.04	66.1244
42	1.4078	39.05	87.80	34.2859	78.10	68.5718
43	1.4216	40.09	88.67	35.5478	80.18	71.0956
44	1.4356	41.12	89.54	36.8158	82.24	73.6376
45	1.4500	42.16	90.44	38.1295	84.32	76.2590
46	1.4646	43.21	91.35	39.4723	86.42	78.9446
47	1.4796	44.26	92.28	40.8431	88.52	81.6862
48	1.4948	45.32	93.23	42.2518	90.64	84.5036
49	1.5104	46.37	94.20	43.6805	92.74	87.3610
50	1.5263	47.43	95.20	45.1534	94.86	90.3068
51	1.5426	48.48	96.21	46.6426	96.96	93.2852
52	1.5591	49.54	97.24	48.1727	99.08	96.3454
53	1.5761	50.60	98.30	49.7398	101.20	99.4796
54	1.5934	51.66	99.38	51.3397	103.32	102.6794
55	1.6111	52.72	100.48	52.9731	104.44	105.9462
56	1.6292	53.80	101.61	54.6662	107.60	109.3324
57	1.6477	54.88	102.77	56.4002	109.76	112.8004
58	1.6667	55.97	103.95	58.1808	114.94	116.3616
59	1.6860	57.06	105.16	60.0043	114.12	120.0086
60	1.7059	58.15	106.40	61.8716	116.30	123.7432
61	1.7262	59.23	107.66	63.7670	118.46	127.5340
62	1.7470	60.30	108.96	65.7029	120.60	131.4058
63	1.7683	61.37	110.29	67.6850	122.74	135.3700
64	1.7901	62.44	111.65	69.7143	124.88	139.4286
65	1.8125	63.52	113.05	71.8094	127.04	143.6188
66	1.8354	64.68	114.47	74.0392	129.36	148.0784
67	1.8590	65.85	115.95	76.3531	131.70	152.7062
68	1.8831	67.02	117.45	78.7150	134.04	157.4300
69	1.9079	68.19	119.00	81.1461	136.38	162.2922
70	1.9333	69.36	120.58	83.6343	138.72	167.2686

APPROXIMATE
ALLOWANCE FOR
TEMPERATURE

At 5° Bé = 0.024° Bé
" 10° " = 0.029° "
" 15° " = 0.029° "
" 20° " = 0.033° "
" 25° " = 0.033° "
" 30° " = 0.033° "
" 35° " = 0.033° "
" 40° " = 0.033° "
" 45° " = 0.033° "
" 50° " = 0.030° "
" 55° " = 0.028° "
" 60° " = 0.027° "
" 65° " = 0 027° "
" 70° " = 0.024° "

For each 1° Fahrenheit

FIXED POINTS*

Bé°	Sp. Gr.	Per cent $ZnCl_2$
5.08	1.0363	3.88
10.16	1.0754	8.05
15.35	1.1184	12.59
20.35	1.1633	17.32
25.14	1.1707	22.02
30.00	1.2609	26.90
35.07	1.3190	32.00
40.15	1.3829	37.14
44.99	1.4499	42.15
50.14	1.5285	47.52
55.05	1.6120	52.77
60.13	1.7085	58.29
65.11	1.8150	63.65
70.05	1.9345	69.42

Specific gravity determinations were made at 60° F., compared with water at 60° F., on solutions of zinc chloride made from chemically pure zinc and hydrochloric acid, these solutions exhibiting a neutral reaction to methyl orange when diluted below 5° Bé with water.

The corresponding degrees Baumé were calculated from the specific gravities by the following formula

$$\text{Baumé} = 145 - \frac{145}{\text{Sp. Gr.}}$$

Baumé hydrometers for use with this table must be graduated by the above formula which formula should always be printed on the scale.

1 cubic foot of water weighs 62.37 lbs. Av.

Atomic weights used:—F. W Clarke's table of 1912. O = 16

*The percentage composition on all fixed points was determined by actual chemical analysis, both zinc and chlorine being determined.

Working Table for Plant Use

The Committee has carefully reviewed the data in the table entitled "Pounds per gallon of zinc chloride at different temperatures for working solutions" presented in last year's report and finds no reason for change. This table is recommended for inclusion in the Manual.

Methods of Figuring Zinc Chloride Dilutions and Concentrations

The Committee recommends that the information presented last year be added to the Manual.

Method of Figuring Volumetric Absorption

The Committee recommends the information offered in 1921 Preservative Committee report under this heading for inclusion in the Manual.

Visual Method of Determining Penetration in Zinc Chloride Treated Timber

This method has proven very satisfactory. It is now an Association Standard.

IV. Revision of Creosote-Coal Tar Solution Specifications

The Committee considered the advisability of revising the present specifications for creosote-coal tar solutions. The specifications as now drawn up specify definite maximum limits of the amounts of tar that may be added and provide tests to insure that these limits are not exceeded, less consideration being given to the influence on the resulting mixture of the individual character of the particular oils and tars used. A more rational procedure would seem to be to consider chiefly the character of the resulting mixture and draw up a specification that would insure the physical quality desired. The Committee has not completed its study of this matter and can only report progress at this time.

V. Specifications for Creosote Oil for Non-Pressure Treatments

Acting on instructions from the Executive Committee and in co-operation with the Chairman of Committees 5—5, Pole Treatment and 7—01, Economics, the following specifications are recommended for adoption as standards:

OPEN TANK TREATMENT. (Defined by Committee on Terminology, Pages 80 and 81, Proceedings of 1917.)

Specifications recommended:

Creosote oil for ties and structural timber. (Page 307, Proceedings of 1917.)

The following alternatives shall be permissible (see note):

(1) "Creosote Oil, Grade 2, for Ties and Structural Timber." (Page 172, Proceedings of 1918.)
(2) "Creosote Oil, Grade 3, for Ties and Structural Timber." (Page 172, Proceedings of 1918.)

Note. Choice of specification is largely a matter of economy. Grades 2 and 3 having respectively larger distillates below 235° C. are consequently subject to greater volatilization, or loss by evaporation when used in open tanks which should be compensated by a lower price. In this connection see "Report on laboratory experiments to determine the loss of creosote by evaporation from open tank treatments," Bateman and Towne, 1920 Proceedings, p. 83.

At a meeting held subsequent to the printing of this report the Committee decided that it had not fully complied with the instructions issued to it. In the press of other activities the Committee apparently did not give sufficient publicity to the proposed specification before presenting it for adoption. The Committee therefore withdraws the specification for surface treatment with the recommendation that it be given further consideration during the coming year.

A liquid grade of refined creosote is recommended as desirable for package shipments, such as drums, barrels, etc., irrespective of methods of treatment employed.

Note on Creosote Specifications

Considerable quantities of English creosote oil not meeting the repuirements of Section 5 of the Association's creosote specifications are being imported at the present time. This section reads as follows:

> "The specific gravity of the fraction between 235° C. and 315° C. shall be not less than 1.03 at 38/15.5° C."
>
> "The specific gravity of the fraction between 315° C. and 355° C. shall be not less than 1.10 at 38/15.5° C."

These specific gravity limits, together with the coke and float tests, were introduced into these specifications in 1917 for the purpose of excluding water gas tar, the Committee at that time having given much study to this problem. There is no doubt but that these clauses have been helpful in barring out water gas tar and oils derived from water gas tar.

The English oils in question are of pure coal tar origin, to the best knowledge of the Committee. Besides the British oil referred to above, quite a considerable quantity of domestic oil is being produced which does not fulfill the specific gravity requirements of the specifications. In view of this situation there is a feeling in some quarters that our specifications ought to be modified. This matter was fully discussed by the Committee at one of its meetings.

It would appear that most of this oil comes from England, particularly from the west of England. However, the Committee has knowledge of several authentic samples of London oil not conforming. The fact that vertical retort installations are found chiefly in the West Coast English plants may account for the character of these particular oils. No data are available showing how much oil is being produced that falls below the gravity requirements of the specifications.

After a thorough consideration of this matter the Committee decided that not enough information was at hand to justify recommending any change in the oil specifications at this time, and voted that a statement covering this matter, together with a table of analyses of authentic samples, be included in its report and presented as information so that the members of the Association might be advised of the present situation.

The Committee voted further that a thorough study be made of this question, having in view making a definite recommendation for revision of this clause next year.

The Committee recognizes, however, that there is a temporary and immediate need for a brief statement which can be appended to the creosote specifications as a footnote to take care of oils which do not comply with requirement five but are otherwise entirely satisfactory. It is therefore recommended that the Association put itself on record as approving the following footnote to the creosote specifications:

Failure to meet the requirements of section five shall not be a cause for rejection of the oil provided the seller can furnish satisfactory assurance as to its coal tar origin.

For analyses of creosote oils not conforming see tables below:

ANALYSES OF ENGLISH CREOSOTE OILS

Sample No.	1	2	3	4	5	6	7	8
Sp. Gr. 38/15.5°C	1.040	1.068	1.064	1.052	1.030	1.045	1.023	1.046
Distillation to 210°C.....	4.1%	4.3%	2.8%	5.1%	4.9%	3.3%	6.0%	3.6%
235	26.4	27.0	22.8	27.1	28.8	27.1	35.7	25.2
315	....	....	....	....	....	70.5	77.3	68.5
355	....	....	....	....	....	88.7	92.8	87.0
Sp. Gr. 38/15.5°C								
235–315 fraction	1.029	1.018	1.022	1.016	1.025	1.024	1.018	1.028
315–355 fraction	1.088	1.130	1.102	1.086	1.083	1.100	1.079	1.085

ANALYSES OF DOMESTIC CREOSOTE OILS

Sample No.	9	10	11	12	13	14	15
Sp. Gr. 38/15.5°C...............	1.082	1.083	1.081	1.051	1.053	1.078	1.083
Distillation to 210°C	5.0%	4.5%	2.0%	2.5%	4.9%	2.0%	3.8%
235	13.8	16.3	14.0	28.0	22.4	13.2	24.2
315	....	....	....	....	....	....	56.0
355	....	....	....	....	....	....	68.0
Sp. Gr. 38/15.5°C							
235–315 fraction	1.027	1.028	1.025	1.022	1.029	1.030	1.024
315–355 fraction	1.094	1.097	1.091	1.094	1.098	1.094	1.083

Creosote Oil Specification for Marine Piling Treatment

This Committee was requested to prepare a specification for creosote oil for marine piling treatment for the use of the San Francisco Bay Marine Piling Committee in connection with their work on the protection of timber against the ravages of marine borers. As a result of this request the following specification was recommended for tentative use until more information was available on which to base a better one.

The oil shall be a distillate of coal-gas tar or coke-oven tar. It shall comply with the following requirements:

1. It shall not contain more than 3 per cent of water.
2. It shall not contain more than 0.5 per cent of matter insoluble in benzol.

3. The specific gravity of the oil at 38° compared with water at 15.5° C shall be not less than 1.03.

4. The distillate, based on water-free oil, shall be within the following limits:

Up to 235° C not less than 5 per cent nor more than 25 per cent.
Up to 315° C not more than 85 per cent.
Up to 355° C not less than 70 per cent.

5. The specific gravity of the fraction between 235° C and 315° C shall be not less than 1.03 at 38° C. compared with water at 15.5° C.

The specific gravity of the fraction between 315° C. and 355° C. shall be not less than 1.10 at 38° compared with water at 15.5° C.

6. The residue above 355°, if it exceeds 5 per cent, shall have a float-test of not more than 50 seconds at 70° C.

7. The oil shall yield not more than 2 per cent coke residue.

8. The foregoing tests shall be made in accordance with the standard methods of the American Wood-Preservers' Association.

9. The tar acid content of the oil when determined by the method used by the American Railway Engineering Association shall not be less than 5 per cent.

Note on Distillation Thermometers

The Standardization Committee of the Manufacturing Chemists' Association has adopted specifications for research and testing thermometers and general use thermometers. In the latter group is one which has a scale range of 10° to 390° C. graduated in divisions of 1° and similar in many respects to the standard A. S. T. M. distillation thermometer of 0° to 400° C. range. It differs, however, in the important point that the M. C. A. thermometer is standardized for three-inch immersion. Hence, if used for any purpose where a full immersion thermometer has previously been used, there would be a very considerable difference in the results.

The new thermometer will be marked "M. C. A. G. 2" and the words "Three Inch Immersion" will be engraved on the thermometer, and there will be a special line at the immersion point. There is, therefore, no danger except by carelessness that these instruments could be confused or used in place of the standard thermometer specified by the Association. (See 1917 Proceedings, p. 315.) Nevertheless, the Committee feels that the matter should be brought to the attention of the Association so that any possible confusion or misunderstanding may be avoided.

Summary

The material in this report is presented as information with the exception of the recommendations given below.

Recommendations

The Committee recommends for adoption as standards and printing in the Manual the following:

1. Method of sampling creosote in tank cars for water determination as described and illustrated in the 1920 Proceedings, pp. 33–38 inc., including example given on page 39, together with amendment found in this report.
2. Volumetric method for the rapid routine analysis of dilute zinc chloride solution as described in this report.
3. Specifications for creosote oil for open tank treatment as found in this report.

The Committee further recommends that the following methods and tables be printed in the Manual for reference purposes:

1. Specific gravity table of zinc chloride solutions as found in this report.
2. Table entitled "Pounds per gallon of zinc chloride at different temperatures for working solutions" as found on pages 63–65 inc., 1921 Proceedings.
3. Methods of figuring zinc chloride dilutions and concentrations as found on pages 66–70 inc., 1921 Proceedings.
4. Method of figuring volumetric absorption as found on page 71, 1921 Proceedings.

The Committee further recommends that the Association put itself on record as approving the footnote to the creosote specification as given on page 52.

Future Work

1. Continue the study of oils derived from vertical retort, blast furnace and low temperature coal-tars and similar products.
2. Study creosote specifications, recommending revision if same seems desirable; also endeavor to establish tolerance limits for the various tests in the specifications.
3. Develop a new gravimetric method for zinc chloride analysis submitting same to practical test before submitting it to the Association.
4. Develop volumetric and gravimetric methods for the analysis of commercial sodium fluoride.
5. Develop a method for the direct determination of sodium fluoride in treated wood.

6. Develop if possible a visual method for determining the sodium fluoride in treated timber.

ALFRED L. KAMMERER, *Chairman*
W. H. FULWEILER, *Vice Chairman*
ERNEST BATEMAN
F. G. BREYER
S. R. CHURCH
L. C. DREFAHL
J. H. GIBBONEY
F. W. KROEMER
K. N. WADDELL
GALEN WOOD

THE PRESIDENT: We have a constitution which says that all matter recommended for adoption as standard must be sent to the members of the Association not less than fifteen days prior to the annual meeting. Consequently we would be violating the constitution if we acted on these recommendations.

MR. CHURCH: Mr. Chairman, Is it not a question of what the Association wishes to do?

THE PRESIDENT: Presumably the Association would like to adopt these recommendations now; but if we let down the bar in one case where can we put it up in others?

DR. KAMMERER: I might explain the history of the report. As usual the report was a little late, but it was completed and sent out to the members of the Committee for vote on the 14th of December, and a copy was sent to the Secretary on December 15 with the proviso that it was not to be printed until he had heard from the chairman as to the vote of the committee. On the 19th of December, I wired the Secretary that the report was released and that was the last I heard of it until I had advice from the Secretary on Dec. 27th that the specific gravity table was not included. This table had been inadvertently left out, and I presume that it was this that delayed the printing. I have not spoken to the Secretary, but that is my guess. As far as the committee was concerned, we tried to get the report out on time to meet the constitutional requirements. If we have not fulfilled them, it is not for the committee to say what should be done in the premises.

THE PRESIDENT: Before getting from you an expression of your attitude toward the footnote which the Committee desires to add to our specifications, we will discuss each of the other subjects. The first is the method of sampling creosote in tank cars for water determination, as described and illustrated in the 1920 Proceedings, pages 33–38, inclusive, including example given on page 39, together with amendment found in this report.

The volumetric method for the rapid routine analysis of dilute zinc chloride solution is up for discussion. There has been some discussion of how plants are determining the specific gravity of their zinc chloride solutions. Since the advent of the Preservatives Committee into the field we have gotten more accurate methods for determining the amount of zinc chloride in solutions. In the olden days, when you could use a hydrometer in determining the strength of your zinc chloride solution, you were able to utilize the six per cent of foreign material in zinc chloride, which helped to buoy up your hydrometer; but according to the method which the Preservatives Committee has developed you determine the soluble zinc chloride only. The question has been raised as to whether the method recommended is too technical or precise. In the case of a contract last year there was argument as to which method was right when there was no clause in the contract stating which method should be used.

MR. J. H. CAMPBELL: Mr. President, what is the reason for this volumetric method in routine analysis when you can use the present standard method and get results almost as quickly as with the one recommended

DR. KAMMERER: I think if any one finds that he prefers to use the present standard method or that it is easier and more rapid, he should make the choice. The committee has not found it so.

MR. DREFAHL: Mr. Chairman, I would like to say a word in regard to the relative merits of the two methods. I am daily concerned with the analysis of zinc in zinc-bearing materials of one kind or another, and I for one would say that proposed method, the base of which was the scheme developed by Mr. Galen Wood, appears to me to be a little simpler for fellows in the field. In a treating plant located near a large central laboratory it would probably be easier and just as fast to work with the present standard scheme, but for the plant off in the woods, which has no direct laboratory control, I think it is a simpler scheme to put in the apparatus which has been recommended and get speedy and accurate results. That is what the committee had in mind when they drafted this particular scheme. It is for plant operators who have no so-called technical skill. It is for the man who has grown up in the field. It is felt that the scheme proposed would be acceptable for the purpose. If you have a technical man who has laboratory facilities the present standard is the better.

THE PRESIDENT: Possibly some of you do not wish to answer this problem as to whether you are going to treat ties with the soluble zinc chloride or with the 100 per cent material. I know it is in the minds of two or three here, but they hesitate to discuss the subject. What is the viewpoint of the Preservatives Committee?

DR. KAMMERER: I shall speak for myself outside of the Committee, as a member of the Association. If you are going to treat with a preservative you are interested in its preservative content. If you are going to use a 50 per cent solution of a preservative you mean by that you are going to use a solution that has 50 per cent of active preservative material, disregarding any water or whatever else may be in that solution, and the same applies to a 94 per cent solid material. If 6 per cent of it is made up of moisture, inert matter, zinc materials that are not soluble, I do not think as preservers we are interested in that material. In order to know what we are working with we should I believe base our operating solutions on the basis of 100 per cent zinc, and also endeavor to draw up our specifications and purchase our zinc on that basis. When we speak of putting a half a pound of zinc in a treated tie we mean a half a pound of chemically-pure zinc chloride. We do not mean a half a pound of 96 per cent zinc or 80 per cent zinc or whatever it may be. I think that is the only basis on which we can take an intelligent stand. I don't quite see what the point at issue is. That would be my personal opinion in connection with my work with railroads and zinc using plants. Maybe Mr. Drefahl can give another point of view.

MR. DREFAHL: Mr. Chairman, I do not know very much about contracts that are made, or the clauses that deal with the amount of zinc chloride that timbers should contain. The committee in considering this work had only one object, and that was to develop a scheme which they could put in the hands of plant operators to determine accurately the amount of zinc chloride in solution. The question of the significance that this method of analysis has with contracts seems to me another matter entirely, Contracts should definitely state what a half a pound of zinc chloride means, whether 94 per cent or 100 per cent. This scheme was designed only to let you determine what you are using in your cylinders.

MR. CAMPBELL: I do not believe that the method proposed as an alternate standard will determine only the zinc chloride or zinc in solution. I believe it will include copper, nickel, possibly vanadium and several other elements which might be present in the solution and which would be counted as zinc by the alternate method.

MR. DREFAHL: Mr. Campbell, from my experience with all grades of zinc chloride on the market I do not know of anything offered at the present time or in the last fifteen years with appreciable amounts of impurities which would influence in any way the results obtained under the proposed method. I do not know of anything which is offered that has enough copper, enough vanadium or other impurities to affect the results arrived at by means of the proposed method. I can not conceive a condition where any impurities such as you have mentioned would be present to any appreciable extent. I am talking simply from what I know of what has been offered on the market in the last fifteen years.

I might state that this method takes it for granted that the sulphite content of zinc chloride solutions is low. The indirect estimation through the chlorime titration is objectionable because there are other materials in commercial zinc chloride, such as lime and magnesia and ammomium chloride salts in a minor degree, which affect to a degree the determination of the actual zinc content of those solutions. The thing aimed at was the estimation of the actual zinc, the major constituent. Any one interested can specify in their zinc chloride purchases that the sulphate content of their material shall not exceed definite limits, which are practically ascertainable in the industry.

MR. CAMPBELL: You have prepared the proposed method for inclusion in the Manual as a standard. A man goes to a treating plant, uses this method, and gets high results on zinc, for some of the zinc solution will come in contact with the brass cocks and other brass or bronze material around the treating plant and take up copper and possibly nickel. Why, I have had zinc solutions come in which were blue probably from copper.

MR. DREFAHL: The only thing I can answer in regard to that is that the method as drawn here (with such commercial zincs as are on the market) gives you a fairly accurate analysis, and it is sufficiently good, in our estimation; for routine operating purposes. There is no gainsaying that the present standard is the better and the more practical in proper environment. If I were a treating plant operator I would much prefer to use the present standard; but this is offered simply as a better scheme than the chloride scheme. The magnitude of error involved in the chloride scheme is very much greater than it is with the scheme which is offered, considering the products which have been offered on the American market. It is choosing between the lesser of two evils. It is understood that the object of the investigation was to develop a better method than the indirect method of chloride estimation which was admitted to be faulty. There is no question about the present standard volumetric scheme being better if you have laboratory facilities to control your plant operations.

THE PRESIDENT: Are there any other questions in connection with the control of zinc chloride? The Chairman of the Committee has withdrawn the specification for surface treatment with oil, page 18.

DR. KAMMERER: We have withdrawn the specification for surface treatment, but have retained our recommendation for open tank treatment.

MR. WATERMAN: Mr. Chairman, do I understand all of Section 5 has been withdrawn?

THE PRESIDENT: No.

MR. WATERMAN: Just the specifications?

DR. KAMMERER: No. Just the specifications under surface treatments.

MR. WATERMAN: I desire to ask the Committee one or two questions. In Section 5 they say that the following specifications were prepared and are recommended for adoption as standard, and that the specifications cover creosote oil only. Is creosote oil the only oil that is used in the non-pressure treatment? If it is not, if other oils are used, why weren't they considered, or will the Committee give us some information on that?

DR. KAMMERER: The committee when they considered creosote oil used that term in a broad sense to include any oils derived from coal tar. They would call an anthracene oil in this sense creosote oil.

MR. WATERMAN: Are there no other oils except creosote oil for non-pressure treatment?

MR. GOLTRA: Or solution?

DR. KAMMERER: I do not believe the Chairman is prepared to answer that. I wish Mr. Hosford would give us information on that point.

MR. HOSFORD: As the report indicates, Mr. Barth and myself were called in consultation upon this matter. As far as the point raised just now is concerned, I should say that a very large proportion of all the preservative material used in what we commonly call today open-tank treatments is creosote of the same type as is used in pressure treatments. From the standpoints of the organization it would seem to me that the function of the Preservatives Committee has been wisely exercised in limiting its report to specifications for creosote. As a matter of fact all it amounts to is that the existing specifications of the Association for cylinder pressure purposes represent what it is best to have in use for the other work. What may happen with other materials than this class of creosote oil is a minor matter. It seems to me that the question that is really up is whether the standards that are used for that creosote are proper and not what should be the standard specifications for something else that might be used.

MR. WATERMAN: Mr. Chairman, it is not very long ago when a fellow who would come in here to introduce anything along the lines of non-pressure treatment would have been treated pretty roughly, but they have a good wedge in here now and I am perfectly willing that they should have it. Now if there are other oils that will give results in the non-pressure treatment, then I think we should consider them. Therefore I move you that this committee change the wording and say the following specifications were prepared and submitted for information.

MR. GOLTRA: I second the motion. In doing so, I understand that it will eliminate the entire specifications under Article 5. I do not see the difference between "surface" treatments and "open-tank" treatments. "Surface" as applied to treating processes is a new word, and I am told that it was coined within the past few years to describe other than pressure processes. In this report I observe that "surface" treatment includes brush, spray and dipping. Well, so far as "dipping" is concerned, that is really the "open-tank" treatment. Perhaps, "surface treatment" should include only brush and spray methods of treatment.

With reference to the specifications of oil recommended for open-tank treatment, would state that, in my opinion, the specific gravity is too low. It should be a heavier oil. If the association is going to recognize the open-tank method of treat ment, we ought to go on record as recommending the best quality of oil, that is, an oil with low volatilization, or in other words, the higher fractions of distillation, usually called "anthracene" oil; an oil that will stay in the wood and not evaporate.

There are other preservatives used besides oil in open-tank treatments, and in my opinion, should be included in a report of this kind. Zinc Chloride is one of them, sodium fluoride is another and I have heard of several others. This reminds me of a case that is pertinent to this discussion. Last summer the architect for Cleveland's six million dollar auditorium, now under construction, inquired for a preservative to treat by open-tank process, about 40,000 square feet of ⅞"x 2½" red beech flooring. He wanted a colorless and permanent preservative. A few weeks ago I learned that the contractor was laying the floor and I went over to examine it. I found that he was dipping the flooring in a substance which smelled, tasted and resembled benzine or benzol. It was amber color, and so far as I could tell it was low boiling fractions of coal tar oil. It was as liquid as water or coal oil.

The oil was furnished by a local concern that manufactures paints, oils, varnishes, etc. I examined the wood that was said to be treated, but I could not tell anything about the penetration; the sales manager of the paint company, however, told me they had furnished 450 gallons of the oil at 79 cents a gallon. At any rate the treated flooring was not discolored nor could I smell or taste much of the chemical in pieces of wood laying on the floor; evidently it had all evaporated from the wood before the flooring was laid. No analysis or tests were made of the preservative. The architect apparently did not know what he approved and did not know what he had specified. This indicates clearly how much actual missionary work must be done with architects and engineers for the good of our industry.

We should not confine ourselves to creosote oil for open tank treatment, but should include chloride of zinc, sodium fluoride, and possibly other preservatives. Architects are specifying more and more the use of treated material by different processes and with different preservatives, and the open-tank method is very often the only way the material can be treated to meet conditions.

THE PRESIDENT: There is a motion by Mr. Waterman, seconded by Mr. Goltra, on the question of changing the recommendation of this Committee. In view of the ruling made earlier it is not possible to adopt this specification because it was not published far enough ahead of our annual meeting.

MR. WATERMAN: Perhaps the Committee will change the wording of that. I would like to explain to you why I brought it up. I have a friend who is the manager of a refrigerator line, and he comes to me and wants to know why he cannot treat the part that decays rapidly with open-tank treatment with zinc. I cited him a half dozen people to get the information from. Remember this is light stuff, inch material. It is the sub-flooring that he wants to treat. He cannot treat it with creosote, because if you put butter or other like articles in the car it will take up the odor of the creosote. Now if he can treat it with zinc we do not want to come out with a positive statement that we must only use creosote oil.

THE PRESIDENT: I do not think the Committee thought they were doing any such thing. You have admitted in your first statement that it was quite a revolution almost to have us submit a specification for open-tank oil.

MR. WATERMAN: Yes, I should say it was.

THE PRESIDENT: It would be a bigger revolution if they proposed an open-tank zinc chloride solution and an open tank sodium fluoride solution.

MR. WATERMAN: All I would ask is that they consider it another year instead of making a positive recommendation.

THE PRESIDENT: They do not hold themselves down to this one oil or this one solution.

MR. BUEHLER: I think if we read the preamble of the report it will be better understood. It says, "Specifications for creosote oil for non-pressure treatments." It does not say specifications for preservatives.

MR. WATERMAN: Yes, but it carries that with it (laughter).

DR. KAMMERER: I may say that the committee understood its instructions to mean an oil preservative, and I think it might be interesting to find out what was in the Executive Committee's mind when they issued instructions to us to draw up specifications for preservatives for non-pressure treatment. The Committee got the understanding from its instructions that preservatives meant specifications for oils to be used in non-pressure treatments. I think you will have to go back of us and see what was in the minds of the Executive Committee when they issued those instructions.

MR. WATERMAN: The average layman will read into it, that creosote is the only preservative for an open-tank treatment, or the only chemical to be used.

THE PRESIDENT: If there are no more remarks all in favor of changing the wording—

MR. CHURCH: I rise to a point of order on this before we vote. If I understand it correctly, these specifications cannot possibly become standards. Then what is the object of voting? They cannot be presented to the Association for anything else than information. Are you asking the Committee by this motion to withdraw the thing and not have it printed in the Proceedings, or what are you asking them to do?

THE PRESIDENT: There is a motion before the house that is perfectly in order. It is the only thing that can be done with this part of the report. You either have to accept it as information or throw it out entirely. Mr. Waterman's motion puts it on the basis of having it accepted as information.

Until this discussion zinc chloride and sodium fluoride solutions for open tank work have not been very seriously considered. If they have a field in open-tank work they certainly should be included in the instructions for the Preservatives Committee next year. Are there any other remarks?

MR. BURNES: Surface treatments are defined as brush treatment, spraying, or dipping. It seems to me that this statement is misleading. From actual observations I know that in the dipping treatment you get penetrations running up to a half inch. I doubt very much whether that would be included here as a surface treatment. Does that not create the wrong impression?

THE PRESIDENT: That whole subject of surface treatments has been withdrawn by the Committee previously, so it is not up for discussion at this time. Are there any other remarks on this subject?

MR. HARTMAN: I would like to ask one question with reference to the definition for the word creosote which was adopted by the Association on the recommendation of the Committee on Terminology in 1913 before our entry into the war. Mr. Church has personally stated that an oil with a certain distilling range or residue would not be considered a creosote oil. If the committee does distinguish between coal-tar distillates as to one being a creosote oil and another not being creosote oil, but being something different, and yet a distillate of coal tar, would it not seem that the definition laid down in 1913 ought to be revised at the present time so as to give us a classification of those wood-preserving oils obtained in the distillation of coal tar.

MR. HOSFORD: Mr. President, I just want to address one remark not strictly to the motion but to something that has been said in connection with it; that is, about the value of high-boiling material for this kind of treatment. The experience that we have had with the open-tank treatment is long and was obtained with creosote that distilled over 40 per cent under 235° C. The results have been good. As a matter of fact none of the creosotes used in the early Forest Service cooperative experiments would pass the 40 per cent requirement. That is the actual limit set up in the proposal of the Committee.

THE PRESIDENT: Are there any other remarks? If not, it has been moved and seconded that the first part of Section 5, relative to the specifications for open-tank treatment creosote oil be submitted as information All those in favor please say "aye;" opposed, like sign. The motion is carried.

MR. HORROCKS: Mr. Chairman, the recommendation, or we will call it the admission of the Committee, that the provisions in 1917 specificatons for creosote oil, with reference to limits in specific gravity on certain fractions, do not protect against the inclusion of other than coal-tar creosote, is a very frank statement that what in 1917 they considered a conclusive test to bar other than coal-tar creosote, will not hold water. I think the Committee has done a very good piece of work in admitting that frankly; but we are faced in a commercial way with the proposition that we are buying oil on that specification. We are apparently faced with some provision in the constitution. More or less accidentally we have run against the proposition that we are not in a position to adopt their recommendation. In other words, we have another year, or possibly longer, in which this specification stands as it was written and adopted in 1917, and we are called on to buy creosote and sell it in the treated timber, knowing all the time, with the authority of Preservatives Committee behind us, that it is not protecting against other than coal-tar creosote and consequently is of no value in the specification, and at the same time is operating to bar creosotes that we know very well are of coal-tar origin. Is there no way this convention can take a position that is not negative, nor tentative, but is absolutely positive in placing this information and this revision before the public in general, and those who are directly interested? If it is in order and workable, I move that their recommendation, as given in their report today be sanctioned, and given all the publicity possible to ease the commercial situation.

MEMBER: I second the motion.

THE PRESIDENT: It has been moved and seconded that we sanction the recommendation of the Preservatives Committee. It is recommended that the Association put itself on record as endorsing the following footnote to the Creosote Specification: "Failure to meet the requirements of Section 5 shall not be a cause for rejection of the oil, provided the seller can furnish satisfactory assurance as to coal-tar origin."

MR. MATTOS: Mr. Chairman, it seems to me that it is unwise for this Association to go out into the world and proclaim that this recommendation presented here today is fool proof, and that we are going to get an oil under its provisions that is going to do the business. It is quite possible to deplete an oil of all its toxic constituents, and still leave it within the limits of this specification. I do not think that it would be wise at this time to consider a specification that is so wide open as this. We know that in the years gone by the users of creosote oil have specified a certain percentage of tar acid and a certain amount of naphthalene. Those oils gave service, but for some unknown reason those clauses have been dropped from the specification, and the result is that we may be supplied a barren oil which is within its boundaries. I think that this is a matter that should be carefully considered before definite action is taken.

MR. CHURCH: Mr. President, I am afraid that the gentleman is not speaking to a point that is really germane to the motion. Apparently it is not possible according to our constitution to alter the existing standards at this meeting, even if we had sufficient evidence to warrant us in so doing, but the motion which Mr. Horrocks has made in reference to the proposal that the committee has presented is merely to relieve, as we have said in our report, temporarily, an immediate condition which calls for relief. I do not think the two things have any particular bearing one on the other. The adoption of this resolution will merely enable the purchasers of oil and sellers of oil to enjoy relief from a condition which has entirely grown up since the original specifications were adopted. Now this question of whether the specifications in the future should be still further safeguarded by requiring certain percentages of definite compounds is one that is well worth considering. We have intimated, I think, that the future work of the committee would tend in that direction, so that we could change our specifications and safeguard the purchasers of oil, but we have not reached that point as yet. As I said, even if we wanted to do something today, we are stopped from doing it by the laws of the Association, and I hope Mr. Mattos will not offer that as an objection to Mr. Horrocks' motion.

MR. DUTTON: That is just the point. I am on the other side of the fence in this matter. I do not believe in leaving the thing wide open so that in buying creosote we don't know what we get. Under this new suggestion we would not know what specific gravity we were to get. We do not know what we would get out of it. I think it leaves it too wide open entirely. We ought to have some definite provision made on the gravity.

THE PRESIDENT: In reply to Mr. Dutton I can only say that I wish that everybody who analyzed oil according to our specifications today knew absolutely that he was getting nothing but pure creosote oil. It is a fact that oils have been and are being produced and accepted by eminent chemists as creosote under oils our specifications, which never saw coal tar. So the recommendation of the Preservatives Committee covers the situation when it says: "Failure to meet the requirements of Section 5 shall not be a cause for rejection of the oil, provided the seller can furnish satisfactory assurance as to coal tar origin." If you have been satisfied in the past with what you have gotten, you now have the leeway of making further investigation to see whether you are really getting creosote oil from coal tar.

You understand this motion proposes a vote of confidence in your specification, and is for use in those cases where an oil is submitted that does not fully meet our standards, which were adopted five years ago. It should be known to you that the manufacture of gas and coke and everything that has to do with the creosote has changed greatly, and the Committee is not in a position, as they frankly tell you, of developing at this time, a new specification. They have made this suggestion, and Mr. Horrocks' motion puts it in such a light that you can show it to interested parties in case your oil does not absolutely meet the specifications.

Mr. Larkin: Mr. President, the Committee should answer this question. Has their recommendation come from examinations they have made of foreign oils that do not meet Clause 5? If that is the case why should they be so interested in changing the specification so as to permit the introduction of these foreign oils? Is it not possible to get our creosote supply in this country? If that clause has been considered as a standard, and a safeguard in the past, should it not be retained? Should we be influenced at all by the fact that there are foreign oils coming into this country that perhaps do not meet that specification which includes the safeguard clause?

Dr. Kammerer: I might say on behalf of the Committee that it was not entirely influenced by foreign oils. It has come to our knowledge that there are quite a few domestic oils, absolutely authentic as far as their coal-tar origin is concerned, that do not comply. It is true, however, that most of the oils that do not comply are of English origin, but the Committee was not entirely influenced in its judgment by foreign oils.

Mr. Horrocks: Mr. Chairman, I notice in the Committee's report there are analyses of seven different domestic oils that do not comply with that requirement.

The President: You should remember that Section 5 was put into our specifications only a few years ago, with the idea of barring out water-gas tar. There was no idea as to differentiating between pure coal tars. Mr. Larkin, is the answer of the Preservatives Committee satisfactory?

Mr. Larkin: Yes.

The President: Are there any other remarks? All in favor of Mr. Horrocks' motion please say "aye"; opposed, like sign. The motion is carried.

Mr. Horrocks: Mr. Chairman, would it be in order to suggest one line of activity for the Preservatives Committee's work this year?

The President: Surely.

Mr. Horrocks: There has been a great deal of discussion and propaganda on the subject of depletion, which I gather is a pretty broad term. Now this has been along the lines of a comparison of what we are getting now in the way of coal-tar creosotes with what we were supposed to have gotten years ago. I believe that if it is possible or feasible, if this Committee could run down and make comparison, run down that question of depletion, segregate or divide the subject, if you please, to locate the elements supposed to be beneficial that are said not to be present in the oils of today, that were supposed to have been present in the past, find the truth of the matter and make a report to this convention, it would be an extremely useful piece of work and would probably throw a good deal of light on a subject that we all want light on. If it is in order I move that that subject be added to their instructions for this year's work.

MR. BUEHLER: I second the motion.

THE PRESIDENT: It is moved and seconded that the Preservatives Committee be instructed to develop the question of the depletion of oils. All in favor of that motion please say "aye"; opposed, the like sign. It is so ordered.

DR. KAMMERER: Mr. Chairman, I move that Sections 1, 2, 3, and 4 in the center of the page under Recommendations be printed in the Manual for references purposes. They are as follows:

1. Specific Gravity Table of Zinc Chloride solutions as found in this report.
2. Table entitled "Pounds per gallon of Zinc Chloride at different temperatures for working solutions" as found on pages 63–65 inclusive, 1921 proceedings.
3. Methods of figuring zinc chloride solutions and concentrations as found on pages 66–70 inclusive, 1921 proceedings.
4. Method of figuring volumetric absorption as found on page 71, 1921 Proceedings.

Those all appeared in our report last year, and I believe the fifteen-day limit has been complied with as far as those particular sections go.

MR. BRIGGS: I second the motion.

THE PRESIDENT: It has been moved and seconded that the four recommendations listed be printed in the Manual for reference purposes. Are there any remarks? All in favor of that motion please say "aye"; opposed, a like sign. It is carried.

MR. DREFAHL: Mr. Chairman, if it is not out of order I would like to thank the collaborators who took part in the work on zinc chloride for their very sincere and hearty cooperation. It was a great pleasure to me to have the spontaneous cooperation that was given.

MR. CHURCH: Mr. Chairman, in behalf of the Joint Sampling Committee representing this Association and the American Society for Testing Materials, and the American Railway Engineering Association, we desire to make one more plea, especially to our friends in the railway treating business, that these methods which have practically been admitted as standard, without trials, except by the companies represented on the Committee and one or two others, be tried by others. Now you have said very earnestly that you wanted a method for sampling tank cars, a referee method so to speak, for the determination of water, and a lot of work was done on it. It took time and it took money, and nobody has taken interest enough to try it out. Please do that or else you will tend to discourage your Committee from further efforts.

MR. HARTMAN: If it is in order I would like to make a motion that the Committee be requested to look into the subject of wood preserving oils obtained in the distillation of coal tar and revise the present definition for creosote to conform with modern practice of coal-tar distillation in the United States.

MR. GOLTRA: I second the motion.

THE PRESIDENT: You have heard the motion. Are there any remarks?

MR. BUEHLER: I think before we could act on that that we ought to have the definition read, and then have it pointed out just where it differs from the present understanding.

MR. HARTMAN: The present understanding, I think, in the coal-tar distilling field is that creosote is the fraction that distills between 230 and 270 degrees.

THE PRESIDENT: As I understand it, this is an instruction to the Preservatives Committee.

MR. HARTMAN: It is a request to reconsider the present definition and to have it revised in accordance with our present understanding.

DR. KAMMERER: Mr. Chairman, should not the formulation of such a definition properly come under terminology, and be referred to such a committee? I would like to have some information on this point.

THE PRESIDENT: I don't think we can sustain Mr. Kammerer in his objection. All in favor of the motion as given please say "aye"; opposed, "no." There is a division on this question.

MR. HARTMAN: The motion is that the Committee on Preservatives be requested to bring in a revision.

THE PRESIDENT: To bring it in?

MR. HARTMAN: Well, to consider a revision, if you will, of the present definition adopted in 1913 for creosote oil, to bring this up to date with the practice now prevailing in the United States among coal-tar distillers.

MR. HORROCKS: Mr. Chairman, are we working on any understanding that dates back to 1913? Haven't we got as far forward as 1917 already?

THE PRESIDENT: Mr. Hartman's motion as last given is now up for vote. All in favor of it please rise. All opposed please stand. Mr. Hartman's motion is lost.

The Committee on Preservatives is now excused with the thanks of the Association.

Mr. Waterman: Mr. Chairman, before the Committee is discharged, I move that we extend to them our thanks for their efficient work and the hard work that they have done in the past year.

Mr. Manley: I second the motion.

The President: It has been moved and seconded that the Committee be thanked for their arduous efforts this past year and that we fully appreciate them. All in favor please say "aye", opposed, a like sign. It is so ordered.

The next paper is one by Mr. Bateman of the Forest Products Laboratory, entitled "A Theory on the Mechanism of the Protection of Wood by Preservatives, Part III, 'Experimental Proof of the Theory by Means of the Toxicity and Solubility Partition of a Number of Tar Acids.'"

Mr. E. Bateman: You have the paper before you, so I will not take the time to read it in toto. Perhaps as an introduction it might be well to go over the papers which have preceded this so that we may have in mind just what we are driving at here. The first paper proposed a theory or working hypothesis which can be summed up as follows: (1) Any substance to be an efficient wood preservative must be soluble in water at least to the extent of producing a toxic water solution. (2) Creosote oil may be considered as consisting of two groups of compounds, one of these being sufficiently soluble in water to render it toxic and the other insoluble and, hence, non-toxic. (3) The non-toxic oil acts as a reservoir for the toxic oils and feeds them automatically to the moisture in the wood.

The second paper consisted in a mathematical treatment of the then existing data and a description of the isolation of a portion of creosote which was non-toxic or barren. This paper showed that at least a part of the theory as proposed was correct, inasmuch as we actually found a non-soluble, non-poisonous material in creosote oil.

The paper before you today shows that the theory as proposed is correct as far as tar acids are concerned if they are present as such in the creosote oil. It does not show that tar acids are the only material which might act as preservatives but shows that when they do act as preservatives they act in accordance with the theory which has been proposed.

THEORY ON THE MECHANISM OF PROTECTION OF WOOD BY PRESERVATIVES

PART III.

Experimental Proof of the Theory by Means of the Toxicity and Solubility Partition of a Number of Tar Acids.

Ernest Bateman
Chemist in Forest Products, Forest Products Laboratory,
Madison, Wisconsin.

Introduction and Summary.

In two previous papers on the same subject there has been presented to this Association a theory on the mechanism of the protection of wood by preservatives and proof of the existence of a large portion of the oil in the non-toxic or barren state. The existence of a solubility partition of the toxic material in non-toxic oil and water has been shown from mathematical considerations. This paper gives a number of determinations of the toxicity of pure organic chemicals and measurements of their solubility partition in barren oil and water. It proves that the theory on the mechanism of the protection of wood by preservatives is correct when applied to tar acids, present as such, in creosote oil. No claim is made that tar acids are entirely responsible for the protection afforded by creosote. In fact, it can be fairly well demonstrated that some of the tar acids are of little value for this purpose and that certain hydro-carbons have a very considerable toxicity. It seems very probable that the active principles of coal-tar creosote can be divided into three groups—hydro-carbons which are soluble in water, tar bases, and tar acids—with the possible addition of a fourth group, viz., those compounds containing sulphur. The tar acids were chosen for the first work because they were known to be toxic, because many of them could be easily prepared, and because an easy method of determining them in their pure state was available when suitably modified to meet our conditions. Work on the other classes of compounds is contemplated and is already under way.

The investigation naturally divides itself into four distinct parts—preparation or purification of the active poisonous materials and preparation of the barren oil; determination of the toxicity of the poisonous compounds; determination of their solubility in water and their solubility partition between the "barren oil" and water;

and tests to show that based on these determinations calculations can be made which will predict with accuracy the toxicity of solutions of the active poisons when dissolved in barren oil. Much of this work which is of a rather technical nature will be omitted from this paper but will be published in chemical journals under the title, "The Phosphomolybdic Acid Colorimetric Method of Determination of Phenols as Applied to Higher Phenols and a New Standard," by C. L. Henningsen, Assistant Chemist in Forest Products, and "The Solubility of Some Higher Phenols in Water and Their Solubility Partition in 'Barren Creosote Oil'" by Bateman and Henningsen.

Materials Used.

The phenols used in this work were either purchased on the open market and subsequently purified at the Laboratory or were prepared synthetically. For the most part the phenols used have been found to be present in coal tar or are probably present but not as yet identified. But a number of phenols that have not been identified in creosote have been added to round out the investigation from a theoretical view point, in the hope that something might be learned as to the effect of various chemical groupings on the poisonous qualities. The phenols used and their sources are shown in table 1, which also indicates whether or not the material is found in coal tar creosote.

From the table and a knowledge of chemical formulas it will be noted that Nos. 1, 2, 3, 4, 5 and 6 form a series in which the chemical formulas differ from each other by CH_2 in the side chain. Nos. 1, 2, 7, 8 and 9 form parts of another series obtained by replacing one H in the carbolic acid by a CH_3 or methyl group. Nos. 1, 17 and 18 form a third series in which the OH or phenol group increases in number. Nos. 10, 11, 12 and 13 may be considered as each being the parent of different series in the same manner as carbolic acid (1) is the starting point from the other series. Nos. 10 and 11 are phenols which bear the same relation to naphthalene that carbolic acid does to benzene. Phenanthrol and anthranol are in a similar relationship to phenanthrene and anthracene. Biphenol is obtained by joining two molecules of carbolic acid, and binaphthol by joining two molecules of naphthol together.

TABLE 1—PHENOLS USED IN THE WORK.

	Chemical formula	How obtained	Found in coal tar
1. Carbolic acid	C_6H_5OH	Purchased	Yes
2. Ortho cresol			
2a. Meta cresol	$CH_3C_6H_4OH$	Purchased	Yes
3. Ethyl phenol	$C_2H_5C_6H_4OH$	Made	Probably
4. Propyl phenol	$C_3H_7C_6H_4OH$	Made	No
5. Butyl phenol	$C_4H_9C_6H_4OH$	Made	No
6. Isoamyl phenol	$C_5H_{11}C_6H_4OH$	Made	No
7. Xylenol	$(CH_3)_2C_6H_3OH$	Made	Yes
8. Mesitol	$(CH_3)_3C_6H_2OH$	Made	Probably
9. Penta methylphenol	$(CH_3)_5C_6OH$	Made	No
10. Alpha napthol			
11. Beta naphthol	$C_{10}H_7OH$	Purchased	Yes
12. Phenanthrol	$C_{14}H_9OH$	Made	Probably
13. Anthranol	$C_{14}H_9OH$	Made	Probably
14. Biphenol	$(C_6H_4OH)_2$	Made	Probably
15. Alpha binaphthol	$C_{10}H_6OH)_2$	Purchased	Probably
16. Thymol	$C_3H_7CH_3C_6H_3OH$	Purchased	No
17. Resorcinol	$C_6H_4(OH)_2$	Purchased	No
18. Pyrogallol	$C_6H_3(OH)_3$	Purchased	No
19. High boiling tar acids	Mixture boiling point 285–380° C.	Extracted from creosote	Yes

Methods Used.

The methods used for determining the concentration of the phenols in water solution was a modification of a colorimetric method used in biological chemistry and known as the phosphomolybdic acid method. This is an extremely accurate method capable of detecting phenols in concentrations as low as one part in 20,000,000, and yielding a fairly accurate determination in concentration as low as one part in 500,000.

The solubility partition of the toxic materials was determined by shaking together weighed amounts of toxic materials, "barren oil" and water, and then determining the concentration of the water solution. The concentration of the aqueous solution multiplied by the weight of water gives the amount dissolved in the water. This weight subtracted from the weight of toxic material originally taken gives the amount dissolved in the oil. The concentration of the toxic material in oil divided by its concentration in water is the solubility partition. The determinations of solubilty partition were all carried out in a thermostat regulated to a constant temperature of 77° F. The temperature was maintained with an accuracy of at least one one-hundredth of a degree. The temperature 77° F. was chosen because this is the temperature at which the petri dishes are maintained in the incubator. The toxicity tests were carried out in accordance with the standard petri dish method used at the Forest Products Laboratory.

Results of Toxicity Tests.

The results of the individual tests have been omitted because of the large number of tests made. Approximately 200 petri dish tests were run to determine the toxicity. The toxicity of the various phenols as determined by us in the petri dish are given in table 2.

TABLE 2—TOXICITY OF VARIOUS PHENOLS AGAINST *Fomes Annosus* BY PETRI DISH METHOD.

Phenol	Toxicity amount required to kill Fomes Annosus	Remarks
1. Carbolic Acid	Per cent	
2. Ortho cresol	0.1	
2a. Meta cresol	0.07-0.08	
3. Ethyl phenol	0.06	
4. Propyl phenol	0.04	
5. Butyl phenol	0.03	
6. Isoamyl phenol	0.04-0.05	
7. Xylenol	0.05	
8. Mesitol	.04	
9. Penta methylphenol	About 0.05	Probably evaporated from petri dish.
10. Alpha naphthol		Saturated solution not strong enough to kill.
11. Beta naphthol		
12. Phenanthrol	0.02	
13. Anthranol		Solubility 0.005 per cent. Saturated solution not strong enough to kill.
14. Biphenol		Saturated solution not strong enough to kill.
15. Alpha binaphthol		Saturated solution not strong enough to kill.
16. Thymol	0.03-0.04	Saturated solution not strong enough to kill.
17. Resorcinol	0.2-0.5	
18. Pyrogallol	0.2-0.5	
19. High boiling tar acids	0.02-0.03	

Particular attention is directed to Nos. 13 and 14 in this table. Biphenol is made by attaching two molecules of carbolic acid together. It might reasonably be expected that this phenol should be at least as poisonous as carbolic acid. It does not seem to have the least effect upon the fungus. It is practically insoluble in water. β-naphthol is the most toxic phenol with which we worked. It might reasonably be expected that binaphthol, a combination of two molecules of naphthol would also be poisonous, but it also does not seem to have any effect. It is almost insoluble in water. The phenols of phenanthrene and anthracene (Nos. 12 and 13) have but little action. They also have a very low solubility. A saturated solution of phenanthrol in water contains two parts in 100,000. This strength of solution scarcely retards the growth of fungus.

Solubility partition determinations were made only on those whose toxicity seemed to warrant further work. Table 3 gives the results of these determinations.

TABLE 3—SOLUBILITY PARTITION OF PHENOLS BETWEEN BARREN OIL AND WATER.

No.	Phenol	Solubility partition at 77° F.
2a	Meta cresol	5.3-5.0-5.3-5.5-5.1-5.0-5.1-5.1
4	Propyl phenol	100-118
5	Butyl phenol	134-136
6	Isoamyl phenol	189.5-181.6
8	Xylenol	22.7-20.3
11	β-Naphthol	49.5-50

From the toxicity and the solubility partition we ought to be able to calculate the toxicity of oil solutions if the theory proposed is correct. In order to test out the correctness of the theory two of the phenols were chosen—both of which are present in coal-tar. They are M-cresol and β-naphthol.

Two solutions of M-cresol in barren oil were prepared one containing 11.37 per cent M-cresol, the other 5.12 per cent M-cresol. Calculations based on a toxicity between 0.05 and 0.06 per cent cresol and a solubility partition of 5.1 shows that in the petri dish between 0.208 and 0.249 gms. of the 5.12 per cent solution and between 0.08 and 0.096 gms. of the 11.37 per cent solution would be required to kill. Likewise, two solutions of β-naphthol in barren oil were prepared, the first containing two per cent the other five per cent of β-naphthol. Calculations based on a toxicity of between 0.01 and 0.02 and a solubility partition show that it should require between 0.131 and 0.396 gms. of the two per cent solution and between 0.0416 and 0.099 gms. for the five per cent solution.

Petri dish tests were then made having at least one concentration of greater strength than required by the calculation, one somewhat less than the calculated and one between the two calculated limits. The results of these tests are given in table 4. In all four series of tests the oils, when the calculations showed they were below the toxic limit, the fungus grew; in all the oils when calculations showed that no growth should be obtained, none was obtained. In other words, if we know the toxicity of the poisonous compound and the solubility partition of the poisonous compound between oil and water we can calculate the toxicity of solutions within the limits of our measurements.

TABLE 4—TOXICITY TESTS OF SOLUTIONS OF TOXIC MATERIALS IN BARREN OIL.

Weight of solution taken. Per cent	Ave. radial growth at end of six months	Calculated result
Toxic oil containing 5.39 per cent cresol		
0.97	(1) 1.5 (2) 2.5	Below killing point range, therefore should grow.
1.18	(1) None (2) None	Within killing point range, may or may not grow.
1.39	(1) None (2) None	Above killing point range, should not grow.
Toxic oil containing 11.37 per cent cresol		
0.39	(1) 6 (2) 121	Below calculated killing point, therefore should grow.
0.48	(1) None (2) None	Within calculated killing range, may or may not grow.
0.56	(1) None (2) None	Above calculated killing point, therefore should not grow.
Toxic oil containing 2 per cent β-Naphthol		
0.29	(1) Over 40 (2) Over 40	Below calculated killing point range, therefore should have grown.
0.68	(11 None (2) None	Within calculated killing point range, may or may not grow.
2.09	(1) None (2) None	Above killing point range, therefore should not grow.
Toxic oil containing 5 per cent β-Naphthol		
0.106	(1) Over 40 (2) Over 40	Below toxic range, therefore should have grown.
0.223	(1) 26 (2) None	Within calculated killing point range, therefore may or may not grow.
0.555	(1) None (2) None	Above killing point range, therefore should not grow.

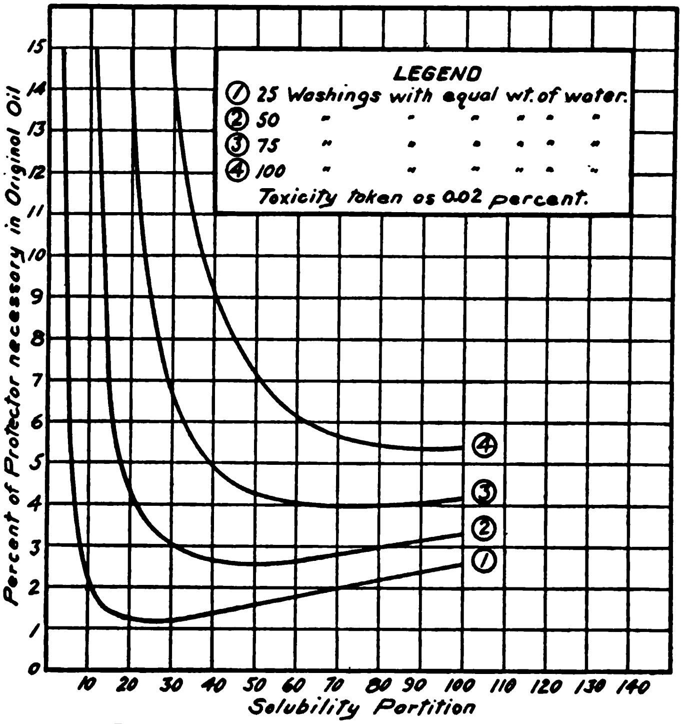
One of the most important factors which governs the value of a preservative is its life, that is, how long will the material act as a poison. The life will, of course, vary with varying conditions. Two of the most important means of loss of poisonous materials are loss by volatilization and loss by leaching. Loss by volatilization is dependent upon the vapor pressure of the poison in the oil and the area of surface of the oily layer exposed to the air. The loss by leaching is dependent upon the amount of water entering and leaving the treated wood and the solubility partition of the poison in oil, or upon the rate at which the toxic material diffuses through the treated wood and upon the solubility partition of the toxic material in water and non-toxic oil. We have at present no data upon the rate of leaching of the toxic materials from woōd, but for our purpose we can take as a measure for this the number of times that we might wash an oil solution with an equal volume of water. If we had such a solution and knew the concentration of the toxic material in barren oil, the toxicity of the pure material and the solubility partition in the oil, we should be able to calculate the number of times we might wash the oil with water and still have the aqueous solution poisonous. If, for instance, a five per cent solution of cresol in barren oil was washed or shaken with an equal weight of water the cresol would divide itself between the water and the oil in the proportion of its solubility partition. If this were repeated a number of times, the point would finally be reached when the water solution would not be poisonous enough to inhibit fungus growth. Calculations based on the toxicity of cresol and its solubility partition show that the effect should be produced at the sixteenth to nineteenth washing. Similar calculations on a five per cent solution of β-naphthol in oil show that the same effect should be reached between 85 and 125 washings. To carry out this number of washings experimentally would be very tedious and time consuming. In order, therefore, to reduce the number of washings larger quantities of water were used. With the five per cent cresol solution in barren oil water equal to five times the weight of oil was used at each washing. With the five per cent solution of β-naphthol in barren oil water equal to 45 times the weight of oil was used at each washing. Calculations show that after the fourth washing of the cresol solution the oil should still contain enough cresol to inhibit the fungus in a petri dish. At the end of the fifth washing the amount of cresol present is within the toxic range and might or might not grow, while at the end of the sixth washing the fungus should certainly grow.

Table 5 shows the results of petri dish tests on various washings made on five per cent solutions of M-cresol and β-naphthol in barren oil and the result of calculations based on the solubility partition theory. Since we are able to calculate the effect on the toxicity of dissolving a toxic material in a non-toxic oil and further calculate the effect of washing this solution with water, it is of interest to show what the effect of the solubility partition has upon the life of the preservative and upon the amount required to protect for a different number of washings. Figure 1 shows a series of curves obtained from calculations of the amount of protector dissolved in oil necessary to make the water poisonous for 25, 50, 75 and 100 washings. When the toxicity of the protector is taken as being the same in all cases and is placed at 0.02 per cent, the curves show that if wood is to be placed where it would be subjected to moderate leaching action such as is equivalent to 25 washings with equal volumes of water, the most economical materials would be those having solubility partitions between 10 and 70, and that a solution containing two per cent or less of these materials would accomplish this end if their toxicity were 0.02 per cent or less. If the leaching is somewhat more severe, equivalent to 50 washings with equal volume of water, the materials should have solubility partitions between 30 and 80. A three per cent solution of such materials would be required provided that its toxicity is 0.02 per cent or less. If, however, as is usually the case, the materials have different toxicities, a slightly different condition is raised. Figure 2 shows the rate at which five per cent solutions of M-cresol and β-naphthol in oil lose their toxic materials when washed with water. The

TABLE 5—EXPERIMENTAL AND CALCULATED EFFECT ON TOXICITY OF WASHING BARREN OIL SOLUTION OF PHENOLS.

Phenol used	Weight of phenol taken	Weight of oil	Water used each washing	No. of washings	Calculation shows that	Found
	grams	grams	cc			
Cresol	.2000	4.034	20	3	Should not grow	No growth
Cresol	.2000	4.060	20	3	Should not grow	No growth
Cresol	.2000	4.083	20	4	Should grow	3-5 mm. growth
Cresol	.2000	4.028	20	4	Should grow	2-6 mm. growth
Cresol	.2000	4.008	20	5	Should grow	6-8 mm. growth
Cresol	.2000	4.156	20	5	Should grow	7-9 mm. growth
Beta-naphthol	.050	2.29	100	1	Should not grow	No growth
Beta-naphthol	.050	2.62	100	1	Should not grow	No growth
Beta-naphthol	.050	2.26	100	2	Probably slight growth	1-1 mm. growth
Beta-naphthol	.050	2.32	100	2	Probably slight growth	3-4 mm. growth
Beta-naphthol	.050	2.13	100	3	Should grow	6-10 mm. growth
Beta-naphthol	.050	2.22	100	3	Should grow	3-7 mm. growth

solubility partitions of these materials are 5.1 and 50.0 while their toxicities are 0.06 per cent and 0.02 per cent, respectively. The minimum toxic concentration of the poison in oil (MTC_o) is, therefore, the toxicity of the compound multiplied by the solubility partition plus 1. For the two phenols in figure 2 the minimum killing concentration of the poison in oil (MTC_o) is 0.35 per cent and 1.02 per cent. These are represented in the curve by straight horizontal lines marked MTC_o. When this



RELATION BETWEEN THE SOLUBILITY PARTITION OF PROTECTOR IN WATER AND IN OIL AND THE AMOUNT NEEDED FOR DIFFERENT NUMBERS OF WASHINGS WITH WATER

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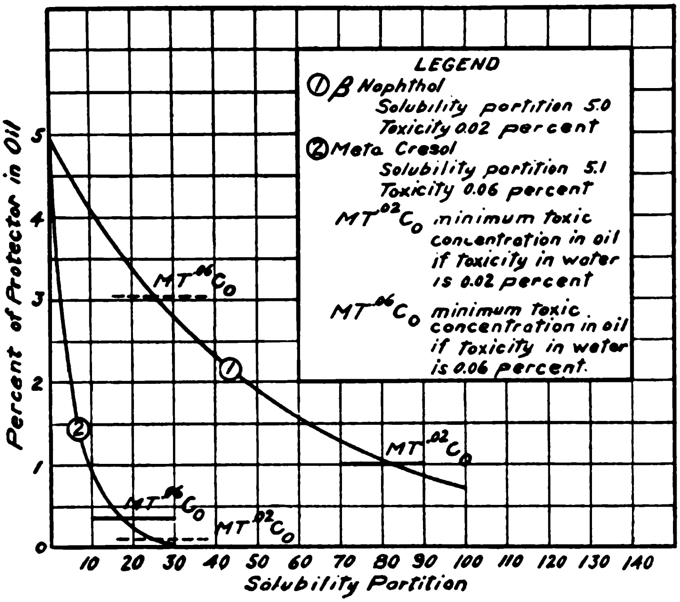
horizontal line cuts the curve, the point of intersection indicates the number of washings this solution may undergo and still have the last washing poisonous. For the five per cent solution of cresol this is 17, but for the five per cent solution



RELATIVE LIFE OF FIVE PERCENT OF β. NAPHTHOL AND CRESOL IN BARREN OIL

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of β-naphthol it is 82, that is the β-naphthol is approximately five times more lasting than M-cresol. If, however, the toxicities of M-cresol and β-naphthol had been reversed, then the minimum toxic concentrations in oil would have been represented by the horizontal dotted lines marked ($MT^{0.02}C_0$) for the cresol and ($MT^{0.06}C_0$) for the naphthol and the life of both solutions would have been the same for the initial concentration of five per cent. This indicates that long-lived preservatives ought to contain very poisonous materials having high solubility partitions.

Conclusions.

It is very evident from the above data that in order to kill timber-destroying fungi by tar acids they must first of all be soluble in water.

In an homologous series the toxicity of the tar acids increases with the size of the molecule up to the point where the solubility is equal to the minimum toxic concentration. If a saturated solution of a compound does not produce a toxic solution, a similar compound, but with higher molecular weight, will not do so.

The permanence of tar acids is governed by their solubility partitions and their volatility. The most permanent are those which are least volatile and have the highest solubility partition.

The most effective wood preserving material is one whose toxicity and solubility partition or volatility are such that it will accomplish its purpose with the smallest amount of material. The amount of material required is dependent not only on the characteristics of the preservative but also upon the kind of service which is required.

The theory on the mechanism of protection of wood by preservatives has been proved experimentally as far as tar acids are concerned.

THE PRESIDENT: There ought to be some comments on this paper. We would be glad to hear them at this time.

MR. REX: Mr. Chairman, I read Mr. Bateman's paper four times before I laid it down. I was pleased to know that we had with us a gentleman who would spend his time on subjects of so vital interest to us, and I cannot conceive of a Government that is spending as much money as our Government is spending for various experimental work, for one moment turning down any request of the Forest Products Laboratory for funds for this work, and I think it is up to us, each one of us, individually, to address a communication to our Senators and Representatives, urging upon them the necessity of liberal appropriations to the Forest Service. [*Applause.*]

MR. BRIGGS: Mr. President, I wish to say that I did that. I sent a communication to our Representative, and I got a very courteous reply from him and also an acknowledgment from the

Secretary of Agriculture under whose jurisdiction I believe the Forest Products Laboratory is.

MR. CHURCH: I do not believe I can say anything more complimentary about Mr. Bateman's paper than to say that it is practically impossible to do it justice in any discussion after so brief a time as has elapsed since we received it. The general purport of his work is not unknown to me, but this particular phase of it is quite new, and must necessarily be considered, in connection with other parts which are not here given. One of the lessons that we can all draw from a consideration of this paper is the necessity for modifying our ideas about what words mean when we consider subjects from a scientific standpoint. For example, Mr. Bateman's whole theory is based on the solubility of certain portions of creosote oil in water, whereas we have all been accustomed to refer to creosote oil as something insoluble in water, in fact, its advocates have often used its insolubility in water in stating its advantages; but most terms when you come to define exactly are only relative and this relative solubility is the thing that we must have in mind, also the fact that in a great many chemical reactions the time element is one of great importance.

I certainly second very strongly Mr. Rex's advice, and hope that Mr. Bateman will be able to carry out his work, and not confine it to tar acids but can extend it to the pyridine series and the other compounds of coal tar. I referred this paper to Dr. Downs, of our Research Laboratory who, with Dr. Dean of Yale University, was one of the pioneer workers on the toxicity of creosotes, having published a thesis on that subject about twelve years ago. He says:

"I have read parts 1 and 2 of these series and believe Bateman is attacking the problem from a new line and at the same time a logical line. If the creosote oil is going to be toxic to wood-destroying fungus, I believe there is not much doubt but that it should be soluble in water as water solutions are the means by which plants take up food. In conclusion I believe he is trying in the right direction, but definite conclusions cannot be drawn until this line of investigation is carried to the limit."

THE PRESIDENT: Are there any other remarks?

MR. BATEMAN: In answer to Mr. Church's request on carrying this thing further, I tried to make it plain that this was only the beginning of the work. We are now preparing to go ahead with work on the hydro-carbons themselves. Later we expect to take up work of a similar character on tar bases and other constituents of creosote, if necessary. We might add that work on these two lines will probably be somewhat more difficult than what we have encountered so far because methods of attack and analysis will have to be worked out individually.

THE PRESIDENT: Are there any other remarks?

As was announced this morning, there will be a slight change in our program. At this time we will listen to Dr. Bartsch who is with the United States Museum at Washington, D. C. His subject will be "American Ship Worms," and his talk will be illustrated (applause).

Dr. Bartsch presented a non-technical gist of a monograph prepared on American shipworms, the illustrations for which had been pinned up on the wall earlier in the day. This synoptic summary passed in review the twenty-seven indigenous species and discussed their classification, specific characters and distribution as far as known today. Lantern slides were used to show the mollusks in question as well as some of the wood destruction accomplished by them. The monograph referred to will be published as Bulletin No. 122 of the U. S. National Museum, entitled A Monograph of the American Shipworms. Persons desiring copies should apply to the U. S. National Museum, Washington, D. C.

THE PRESIDENT: Gentlemen, this paper of Dr. Bartsch's is now open for discussion. If any of you have any questions that you would like to ask Dr. Bartsch he will be very glad to answer them.

MR. HUMPHREY: Mr. Chairman, I would like to ask Dr. Bartsch if there are any means of distinguishing the different genera or species of these worms outside of the pallets or do you have to rely entirely on them?

DR. BARTSCH: The few animals that I have had the opportunity of examining show that we have no exception in the ship worm when compared with other organisms. In other words, the study of the animal confirms the evidence presented by the skeleton that these are natural groups.

DR. VON SCHRENK: Mr. President, I was very much interested in Dr. Bartsch's presentation. I would like to make a few comments. In the first place, I would like to offer a correction of his statement with reference to that Cuban piling. He said it was creosoted piling. At the time that piling was driven I happened to be chief of the division of the United States Forest Service and I made the prediction at that time that that piling would not last two years. It did last four, according to Dr. Bartsch. I made a trip to Cuba at the time the wharves failed, took samples of the piling and I can assure you it was not creosoted. The creosote oil specified for the treatment of that material at the time would have cost more than the total sum did. I will let you judge as to what was in that piling. In other words the experience of the Cuban creosoted piling indicates that it was not creosoted at all, as we now understand it.

If the hour were not so late I would like to take up a little time and ask Dr. Bartsch a number of questions. I was very much interested in his statement as to the biological distribution of the animals. Being somewhat of a biologist myself, I have studied the migration of races and I cannot help but take some exception to his very positive conclusion, simply because an organism has not been anywhere that it must necessarily be limited to its original geographical location. We unfortunately know very little about the animals of the sea largely because our knowledge of the environmental conditions under which sea animals live is still so full of gaps, but we do know a good deal about the distribution of land animals. However, I agree entirely with him, that the determination of the possibility of the existence of a species may and probably is determined by very specific and very closely limited environmental conditions. Take the case of land animals; within the last eight or nine years we have had the incursion in the southern states of the so-called Argentine ant, an insect which probably lived in the Argentine Republic for centuries. Our communications with the South American republic have been numerous and extensive for the last hundred years or more and yet we never had that insect in North America. For some unknown reason it suddenly appeared in our Gulf states. A bulletin from the Department of Agriculture just published shows that that insect has driven the native ants of southern California out and has taken possession of the country.

We have numerous instances similar to that. For instance, the bark beetles appeared in West Virginia some fifteen or twenty years ago. They lasted there about three or four years. Nobody knew where they came from and they vanished just as quickly as they came. Then they jumped to the Black Hills of South Dakota, where they were just as numerous for eight or ten years, and then disappeared. The most recent accounts show there has been a similar incursion in Mexico. I feel therefore that the mere appearance of this species in San Francisco Bay is a biological factor that might easily be explained. In other words, the mere fact that it had not been there before does not by any means prove that the animal could not come across the seas in some manner or another.

For instance, a few months ago an organism which so far as those of us who examined it could tell, is exactly the same as the form we know from San Francisco and the same form that I personally have collected many a time along the northern European coast, appeared only twenty-five miles from the harbor of New York.

What we as engineers and wood-preservers are interested in is a definite situation. I personally all along have held that while we are interested in specific differences of these various groups we are interested in them only to the extent as they may affect our actual operations.

As will appear from the report of the San Francisco Bay Piling Committee, comparisons have recently been made both of the organisms that occurred at San Francisco and the European specimens which were sent to this country, and vice versa, and without going into too great technical detail as to specific differences (with which biologists I am sure Dr. Bartsch will agree, frequently differ), the points that we are interested in now are protective measures. As long as there appears to be some significance in a possible relation between the San Francisco organism and the European organism it behooves us to be on the job and not to be remiss. I think I can speak for this Association as well as for others interested in this problem, that what we want to know, what we are interested in following, are the investigative processes which are now being conducted to determine whether there is the possibility of a destructive organism appearing at other points. We all know that these organisms are working powerfully fast, and we want to be ready for them in any locality along our ports wherever they may appear. Whether the specific differences between the European organism and the San Francisco organism are large or small or whether they ought to be called by a different name, I think that interests us less than the fact that their activities are very similar, and that they work under the conditions which recent European experience has shown. I believe that the work which Dr. Bartsch has shown here has emphasized the desirability of a very careful scientific analysis of the different species, keeping in mind the commercial importance which one or the other may have for our particular circumstance.

DR. BARTSCH: First of all, I wish to say that the San Francisco committee showed beautifully that the mollusk was not one of recent incursion into that fauna, but one that had made its presence felt at former periods. What the report showed most clearly, above all things, was that the Sacramento and San Joaquin Rivers had gone low through several seasons of little rain and through water being abstracted for irrigation purposes. Taking fresh water from the river did not change the sea level in the tidal region but caused an ingression of the sea into the Mare Island region, San Pablo and Suisun Bays, making it possible for the shipworm that had been in

San Francisco Bay, *Teredo beachi*, not *Teredo navalis*, to follow up this ingression of salt water. I wish to state that if Dr. Von Schrenk had spoken about fungi I would not have questioned his dictum, but when he speaks of mollusks, I may say that he knows nothing about them. I am equally willing to say that if Professor Kofoid were to speak on marine protozoa I would remain silent. because my knowledge in this field would be insignificant compared with the information at his command. However, when it comes to shipworms, I can say that I have studied them for twenty years, and I will eat every specimen—and by the way they are good to eat—of *Teredo beachi* from San Francisco Bay that you can prove to be *Teredo navalis*. This is not a new infestation at all. It is an ancient history that has repeated itself. This mollusk seems to prefer estuarial conditions and when there has been a change in the extent of such an environment through ingression or regression the shipworm larvae have followed up the condition. I do not know how many larvae *Teredo beachi* is able to produce, but probably a half million to three million. It is probable that they may mature in three months. Some shipworms do mature in that time. At that rate of reproduction, therefore, it would not take very long to get enough shipworms in there to do great damage. Multiply a half million by each one producing, beginning with one, you may have a half million times a half million in half a year and half a million times that many in three months more. The numeric progression is such that it would not take very long to eat up all your pilings out there.

When it comes to a question of this kind, let us have only one thing in mind, a scientific enquiry without politics. I approve highly of having an international committee that will look into the matter of shipworms and their control the world around, for it is not an American problem only. It is a problem that presents itself on all the sea coasts of the world. I am not saying that shipworms can't be carried from one place to another, but I am saying that I have no record of their being able to establish themselves in new environments.

You do get ingressions of some mollusks. We have a little Asiatic *Eulota*, a small land snail, which has been carried the world over by commerce. There are many islands in the West Indies in which it has established itself, but there are other mollusks that can't colonize. If shipworms could be as easily colonized as they are carried by wood bottoms or by drift wood, we should have only one shipworm fauna in the world, which is not the case. In the days gone by there were nothing but wooden bottoms. That would have been the time in which the investation should have taken place, but it didn't. To meet your criticism I may say that the big barnacle which attaches itself to every ship bottom when it goes to the tropics, *Quintinobula tintinabulum*, should be distributed to all ports by them. When I went to Hawaii I expected every ship bottom, pile, wharf and stake to be one solid crust of *Quintinobula tintinabulum*, but the only place where we found them was where they scraped the ships. Why? These barnacles must pour out millions of eggs and larva wherever the ship anchors for any length of time, and yet not one seems to have been able to establish itself there. Why? I don't know! Nobody knows. We do not know enough about the physical features, the environment of the sea.

As an example of the difficulties encountered in transplantation, I may mention the oyster. How long has the West Coast longed for our luscious East Coast oyster? How many carloads have been carried over and dumped into San Francisco Bay? Is the oyster located or established in San Francisco Bay? Not by any means. The only thing that did carry over is a little periwinkle, which seems to flourish there better than it does on the East Coast. What are the conditions that are required by the oyster? If you look it up you will find that if the temperature is otherwise than just within two degrees of a certain line, the sperm and the egg won't float to the surface where fertilization takes place. In other words, the male elements and the female elements won't have a chance to meet, and consequently no fertilization takes place.

Now it is possible that we may have a similar state of affairs in shipworms. I feel we should get busy and secure this information. I am willing to concede that we know little about them, except what constitutes a species and what does not constitute a species, and I am willing to risk my reputation that this *Teredo beachi* is not the European shipworm or even very closely related to the European shipworm.

MR. MATTOS: It is very unfortunate that Dr. Kofoid is not here to reply to Dr. Bartsch's remarks. Personally, I do not feel equal to the occasion, but I want to say that Dr. Kofoid did not rely upon his own identification of the mollusk that we are talking about at the present time, but he had material sent him from at least a dozen different European ports. This material supported his identification that it was *Teredo navalis*. On the other hand, we sent material to Paris and this material was identified by Dr. Lamy as *Teredo navalis*, the same species that has caused so much destruction in European waters. Material was also referred to Dr. Calman, a British specialist on marine borers, and Dr. Calman reports back that our material is unquestionably *Teredo navalis*, the species that has caused so much destruction in that territory. Now I think that this Association owes it to Dr. Kofoid to at least present him before this matter is finally thrashed out, with a copy of Dr. Bartsch's report, so that he can present to this Association a written discussion on the remarks and the report presented.

DR. BARTSCH: Mr. Chairman, there is no question of any requirement or any report or anything else, because I have published these things over my own signature and stand sponsor for them in print, and no report that you might present could alter one whit of what was writ, because the thing that will stand is the ultimate finding. If my name, *Teredo beachi*, should be faultily applied, scientists, when they come to work on this thing, will relegate it to the scrap heap. In regard to Dr. Calman, I may say that he appears to have a rather broad concept of what constitutes a species. I might say that Professor Kofoid's work on the free swimming protozoa is the most brilliant work that has ever been done in this line in the world. There is no man living today who can come anywhere near Professor Kofoid when it comes to a knowledge of the free swimming plankton.

DR. VON SCHRENK: I would like to ask Dr. Bartsch one question. In case your viewpoint of this matter is correct, would you interpret any effort for protective or preventive measure on the Atlantic Coast as absolutely futile? In other words, would you say that there would not be problems on the East Coast and on the Gulf similar to what they had in San Francisco Bay?

DR. BARTSCH: If you mean protection against *Teredo navalis*, yes, because this organism does not occur on the east coast of America. The only specimens I have known as *Teredo navalis* in our museum collection are those that were said to have come from a plank that belonged to a British vessel sunk by the American Navy in our scrap with them on the Northeast Coast, and you know when that was. Now that is the only true *Teredo navalis* that I have been able to find. As for an attack of this particular species, why bother about this species? Every shipworm is a menace. You have enough shipworms on the Atlantic Coast today to give you all the worry you could possibly want without having to import one from the other side. There are four American species that have been reported in Europe that have drifted over there and if they were kicking on the other side about an infestation from America, why, the thing would be much more reasonable, because the only way we could get them from Europe would be in a wooden-bottom vessel, and the fact that they did not establish themselves in the past when wooden bottoms were in use in Charleston Harbor, New York Harbor, or any other harbor in the east American region, seems to me is the finest proof that you would possibly want against worrying about *Teredo navalis* in American waters. Get busy on the others. I have shown you twenty-seven species, in addition to which there are six more, of which I have only fragmentary material. This would seem enough to worry about. Get busy and find ways and means of controlling these. I saw a wharf a half mile long go out in three months at Cape Charles. Of course, it was untreated wood. If that is not cause enough to worry I would like to know what is.

One more thing. I believe every piece of piling that is treated, successfully treated, particularly if it is treated with a substance that is toxic, so that it will kill these larval forms is a blessing to the harbor. The use of treated timber should be a matter of legislation, because if a piece of treated wood will kill these larvae it will prevent their growing up and giving birth to off-springs. But what has that got to do with that *Teredo navalis* (laughter and applause).

MR. MATTOS: I just wanted to state one thing, and that is that during the work of our Committee we have had *Teredo* in captivity and we have had them in some cases in, you might say, stagnant water, that is, still water. We wanted to see how long they could live in that water without changing, and in examining the water every day we found that the food supply multiplied instead of diminished. The result has been that we have *Teredo* in that state for at least four or five months, and thriving well. Now I believe Dr. Bartsch stated that it was impossible to transport *Teredo* in ship bottoms.

DR. BARTSCH: No.

MR. MATTOS: Didn't you say that?

DR. BARTSCH: No. You can transport them, but they don't seem to be able to reproduce themselves.

MR. MATTOS: I just wanted to bring out the point that the result of our work would conclusively prove that the larva could be transported in ship bottoms.

DR. BARTSCH: It can. I agree with the gentleman completely. There are four species which are constantly being thrown up on the coast of Europe, some of them perfectly alive and healthy, but in spite of the fact that they are transported over there year after year and month after month, they have never established themselves in Europe. The conditions are not so suitable—they are American ship worms (laughter).

THE PRESIDENT: Members, we have a very full program. There is one more set of slides that we have to run off this afternoon, and a paper will be presented in connection with the slides. It is: "Photography and Wood-Preservation" by Mr. Henri Strawn, who is the official photographer for the Sante Fe. You need to listen to this paper because we need more good photography in wood-preserving.

PHOTOGRAPHY IN WOOD PRESERVATION*

By C. Henri Strawn

Photographer, Atchison, Topeka and Santa Fe Railway Company

In compliance with a request from your President, I take pleasure in presenting to you this paper and hope you will give me your kindest indulgence in my efforts to portray to you the many advantages and also some of the difficulties that accompany photography, especially as it applies to the industry of wood preservation.

Photography is quite a large subject and I shall try to cover as much as appears pertinent to the subject in the time at my disposal.

As it is not always possible or practicable to have a professional photographer at your disposal, I will confine myself to the requisites which I think are necessary for anyone, with a fair knowledge of the subject, to get the best results.

In my experience, the first and most essential thing is a good serviceable camera for the purpose. A 3-A size, with any good standard make of lens and shutter, would be the most satisfactory instrument you could use for most work and also one that can be conveniently carried, as it is very compact. This size, 3¼x5½, makes a good size to use and one that can be enlarged if you so desire.

The lens should have sufficient focal length to enable you to get any desired distance from the object you are taking. This will require an extra long bellows and front extension, as practically all cameras are set for six feet and upwards to 100 feet, and you will find that the great majority of the photographs you will want to take are close-ups. Where detail is to be shown, the above combination should be just what you want. In addition, you should have a tripod, as 50 per cent of the photographs for this class of work require time exposure and this is impossible without the aid of a tripod. There is a small steel one on the market which serves the purpose very well. I would recommend the use of films as they are much easier to handle than plates. They are also non-halation, and in my opinion, give better results for all-round work such as you will do.

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* A paper for presentation at the Eighteenth Annual Meeting of the American Wood-Preservers' Association, Hotel Sherman, Chicago, January 24, 25 and 26, 1922.

The outfit outlined above, if properly used, will make any picture from any length exposure to a moderately high speed exposure.

The majority of people using cameras think that all they have to do is to point at the object they are taking and snap it, regardless of existing conditions. They also think if they have a good lens and shutter, that is all that is necessary. This practice is the reason for the large number of failures in taking photographs among amateur photographers.

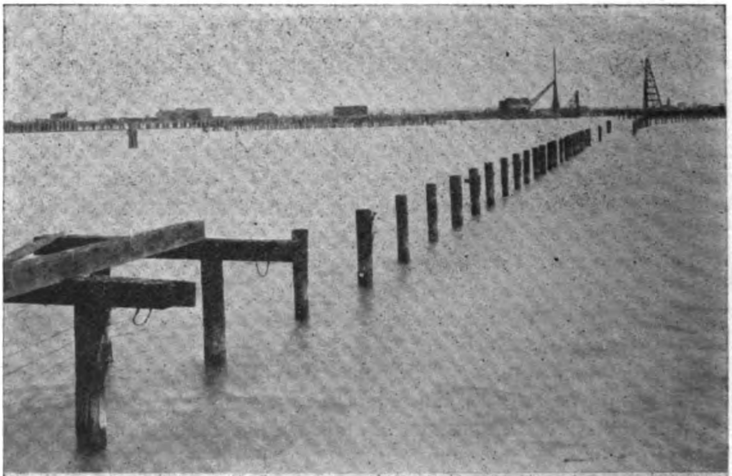
The majority of photographs taken in connection with wood preservation are taken under the following conditions. First—they must be taken at all times of the day regardless of the position of the sun; in all kinds of places and all kinds of light. This, within itself, is a problem that experience only will solve. It is most essential that you get the suitable light on the object you are going to take, as high light and shadows are what makes all pictures possible; therefore, you should move the camera around until you find the light that will give you the best results, that is, if the object is in a position where it can be taken from several different angles. If it is sunlight, turn the diaphragm as indicated on the shutter for this kind of light and give it a snap shot; you will, of course, have to be governed by the time of day the exposure is made, as the light is much weaker in the morning and evening than at midday, also the sun is much brighter in the summer than in the winter. You should bear this in mind always, and as stated above, it makes a vast amount of difference as to the time of day the exposure is taken. It you have very dark shadows in which you wish to show detail, it should have more than a snapshot, as the high lights will always take care of themselves, the shadows are what you must be careful of. The above only refers to the average photograph. If more detail is desired in the foreground, or in the distance, or both, use the tripod, stop the diaphragm down further and make it a time exposure, the more the diaphragm is closed, the more exposure is required and you will find this will give you a clear sharp photograph.

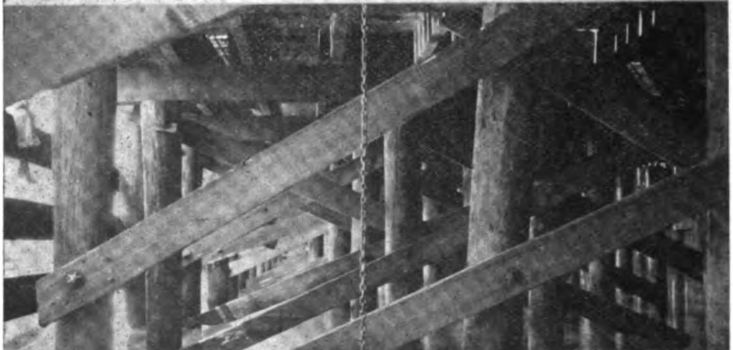
In case you want to make an exposure when the light is very poor, such as under bridges and other equally dark places, set the kodak the correct distance from the object you are going to take, close the diaphragm to a reasonable opening, and make a time exposure, which under unfavorable conditions, may require an exposure of five or ten minutes or longer. You will, of course, have to use your own judgment as gained by experience regarding the time it requires and if possible, do not have the camera facing the strong light, as this will cause a certain amount of halation, and if the light is strong enough, the halation will spoil the picture. If you have to take the photograph against the light, do not stop the diaphragm so far and give it less time, and always remember that a film over-exposed to a certain degree, can usually be taken care of and fairly good results obtained, but one under-exposed is very seldom a success. On the over-exposed, the object is there in some form, while on the extremely under-exposed, it is not there at all. If you are taking photographs on a cloudy day, it doesn't make any difference which way the camera is pointing, as all the shadows have a soft light and you will find this to be the ideal day to obtain fine detail, and only time exposure should be taken if possible, unless the object you are taking is moving and then open up the diaphragm and take a snapshot, timing it according to the movement of the object.

The taking of the photograph is not the only essential thing, as the finishing is equally important. Fine negatives are often spoiled by some one that does not know the proper way to develop and print them.

Most any negative, either over-exposed or slightly under-exposed, can be brought out by using the proper kind of paper. Therefore, if you are not in a position to do this work satisfactorily yourself, take it to some one who knows the business and not to an amateur, who can very easily get you discouraged by the results he gets from your efforts. If you gentlemen will use as much care and precaution in making a picture that is obtaining a permanent record of your work, as you do in the preservation of wood, your photographs will be a success. If they are to be of real service to the profession, it will be admitted by all of you that detail in every particular should be the first aim, and this can only be accomplished by giving the subject a little careful study before you make an exposure. You are sure to have failures, but do not let this discourage you, as experiments on these failures will ultimately bring success. And remember, if a picture is worth taking at all, it is worth taking well.

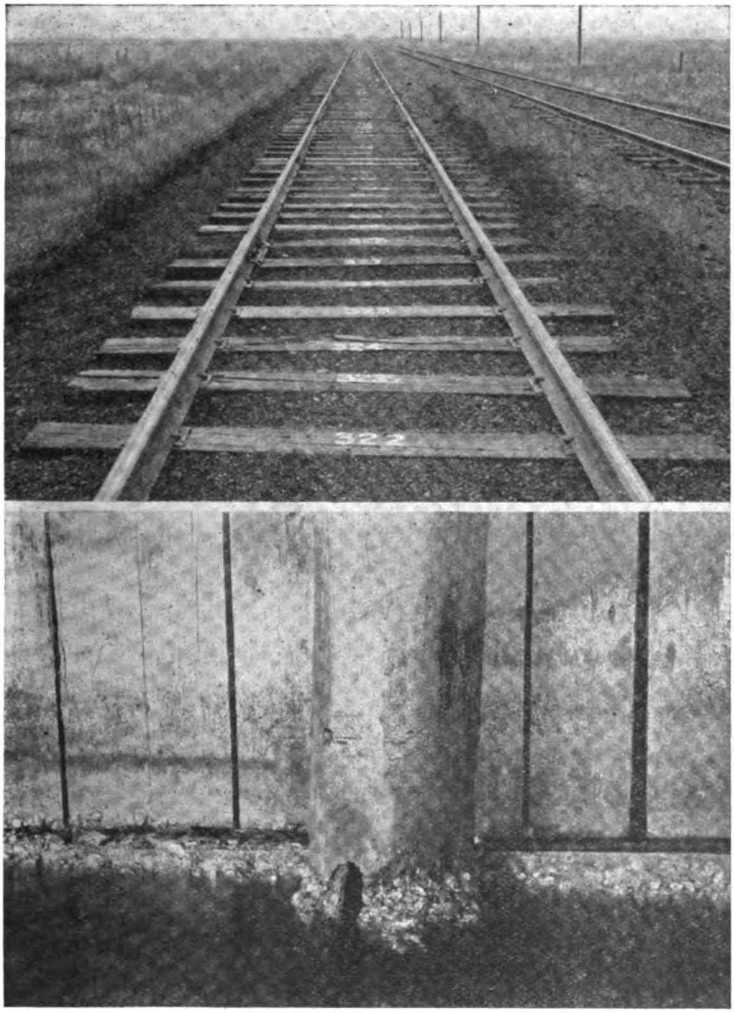
I have given you briefly the fundamentals for taking good photographs, and the following illustrations will, I hope, demonstrate to you more fully than I can otherwise explain, the correct method to be adopted to obtain the best results.





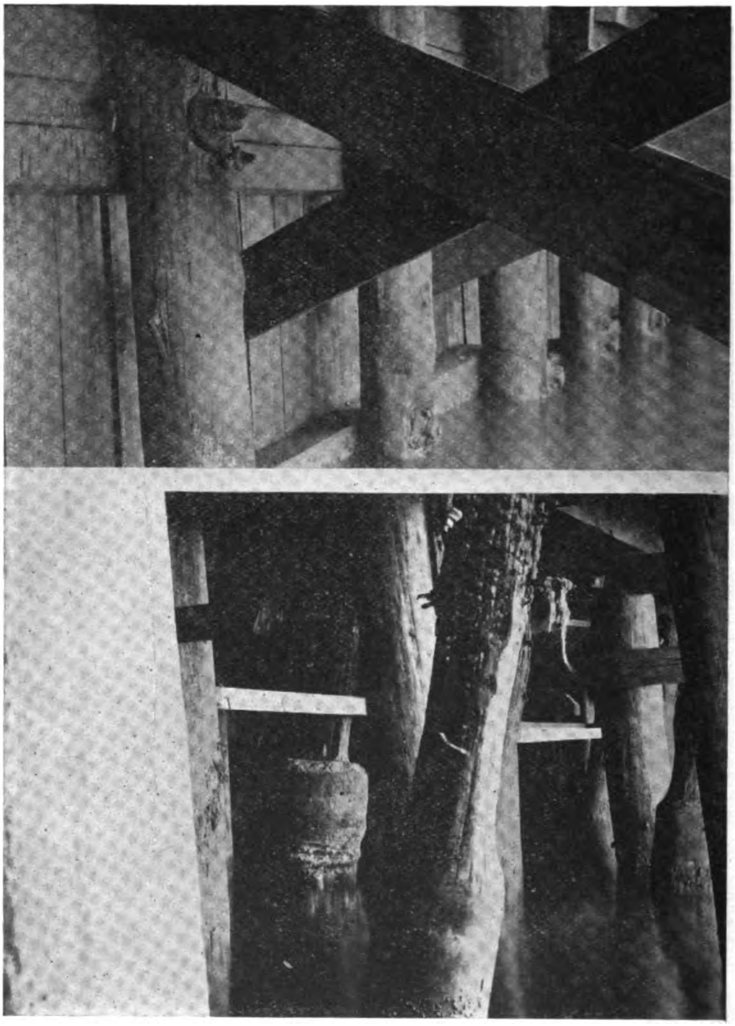
ABOVE. Photograph taken during rain storm. Note detail on all piling regardless of existing conditions. Camera was sitting on dock which moved with the motion of the waves. Diaphragm stop 22, exposure ½ second.

BELOW. Photograph taken under dock showing sway braces eaten off by teredo. Strong light at the left, but detail was brought out in the printing. Diaphragm stop 45, exposure 5 seconds.



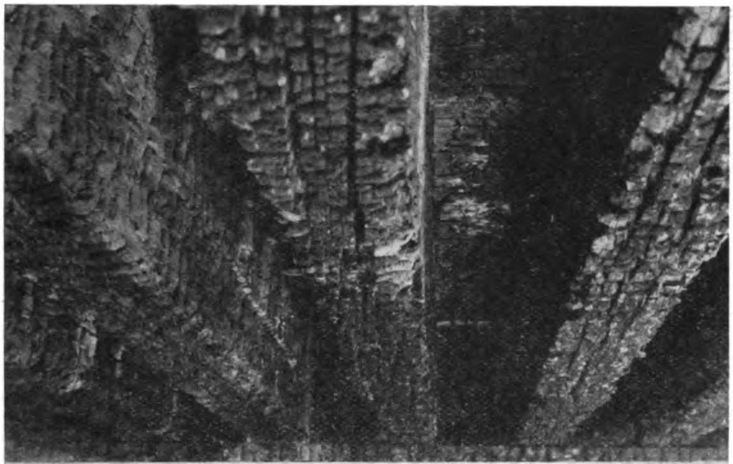
ABOVE. Photograph of railroad track taken on very foggy morning in November, 8:30 a. m. Regardless of conditions, the track is visible for some distance. Diaphragm stop 45, exposure 20 seconds.

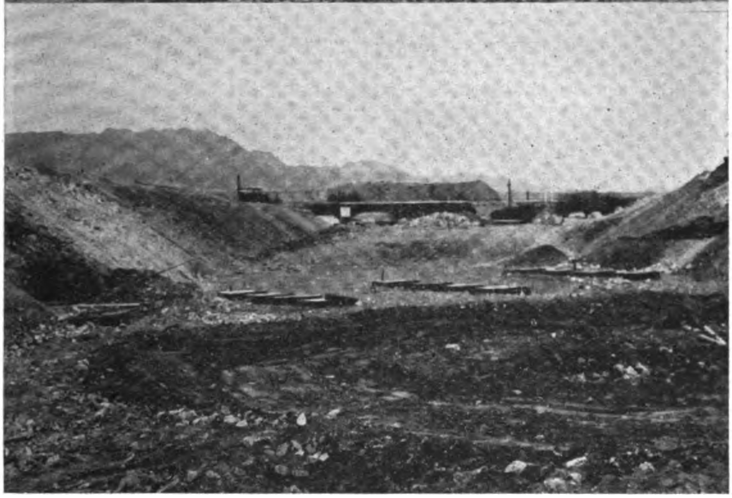
BELOW. Photograph of rotten piling and bulkhead under wharf; waves were washing up and down on the object taken. A wide open diaphragm and a shorter exposure would not have given these results. Diaphragm stop 45, exposure ½ minute.



ABOVE. Photograph taken under wharf showing bolts in piling and bulk-heads. Camera laid on sway braces and held during exposure. This is not good practice, as a slight movement would have ruined the picture. Diaphragm stop 32, exposure 20 seconds.

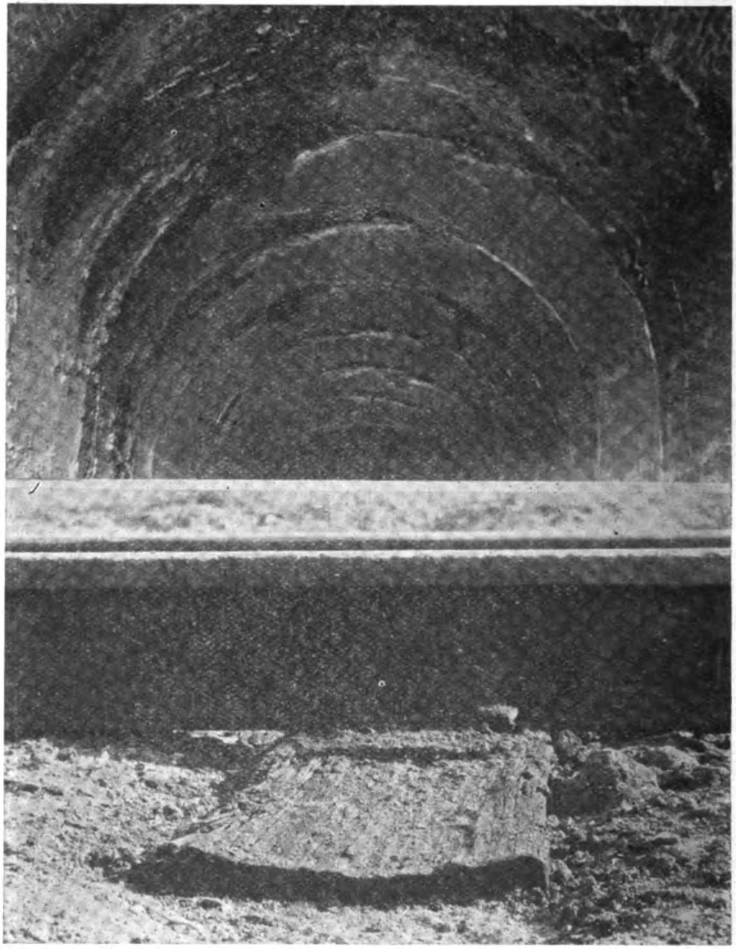
BELOW. Photograph of concrete covered piling under wharf at 7:00 a. m. This negative is a little under-exposed but was brought out fairly well in the printing. Diaphragm stop 45, exposure 5 minutes.





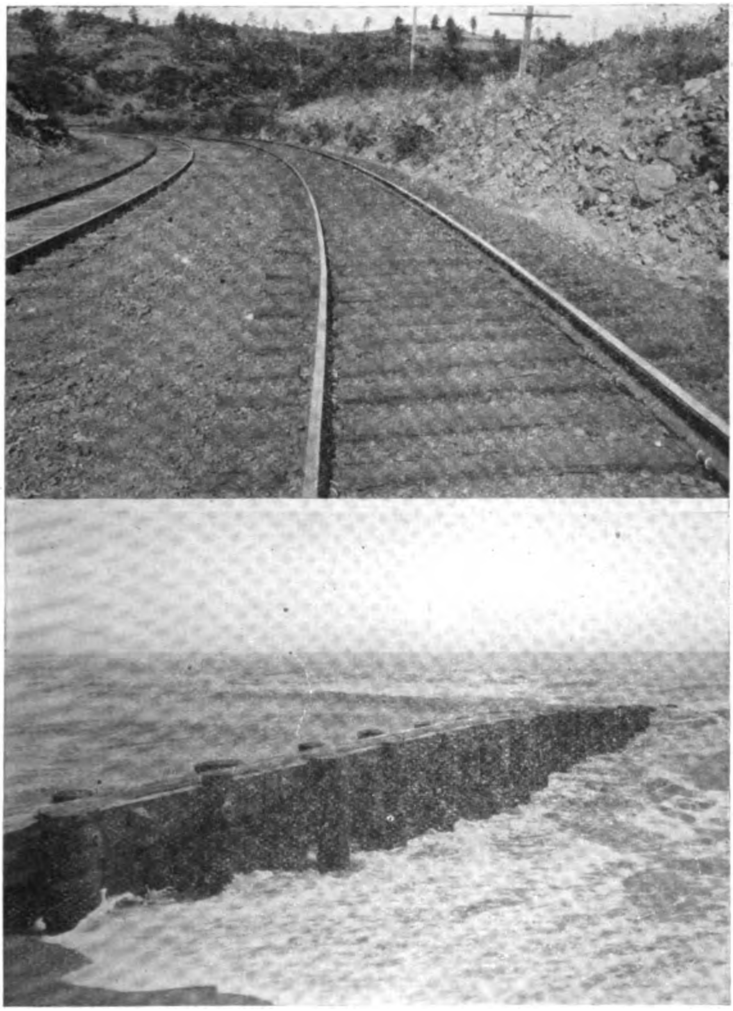
ABOVE. Photograph taken under burned creosoted piling bridge, which was about 7 feet from the ground. Light reflected by white paper laid in the sunlight on the ground partially under the bridge. The timber was badly charred and very black. A flashlight should have been used. Stop 22, exposure 11 minutes.

BELOW. Photograph of excavation in mountains after sun had been down about 40 minutes. Darkness made it necessary to guess at the focus. Note detail in foreground even at this time of the evening. Diaphragm stop 22, exposure 25 minutes.



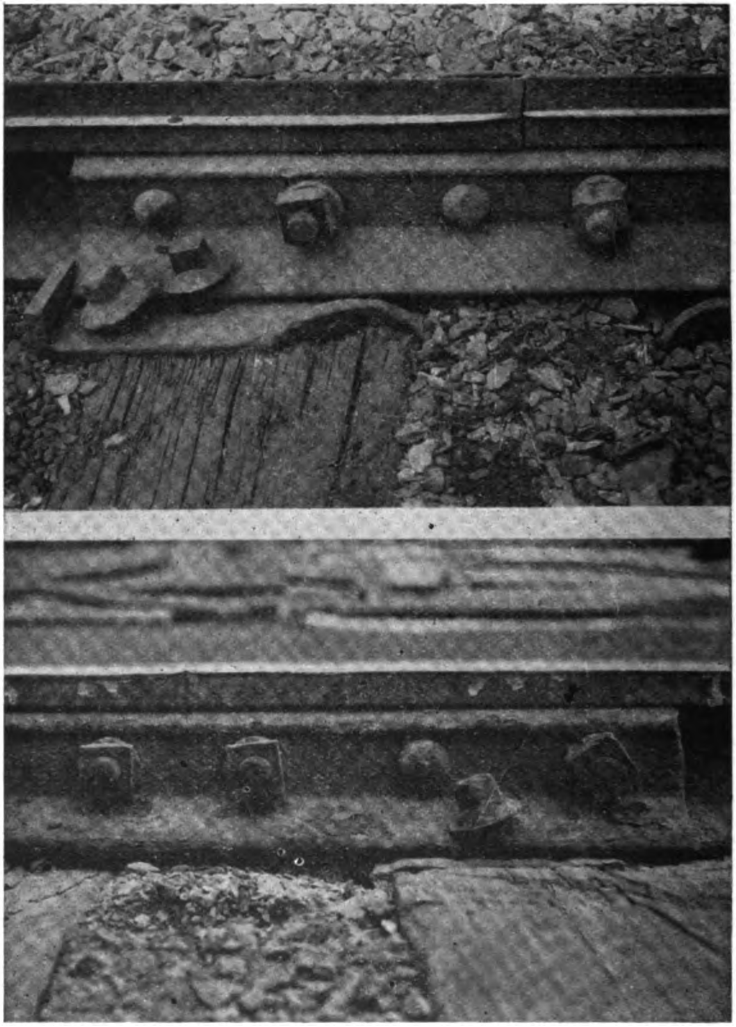
ABOVE. Photograph showing defective masonry in tunnel 150 feet from entrance. Light reflected by white paper laid on the ground in the sunlight outside. White blurred spots in upper foreground caused by water dripping. Stop 45, exposure 2½ hours.

BELOW. Photograph showing curved condition of tie. Note shadow at end of tie which was necessary to bring out the curve on account of tie and ground being same color and also being heavily oiled. Sun shining directly at the end of tie would not have shown this condition. Stop 16, exposure 1/25 second.

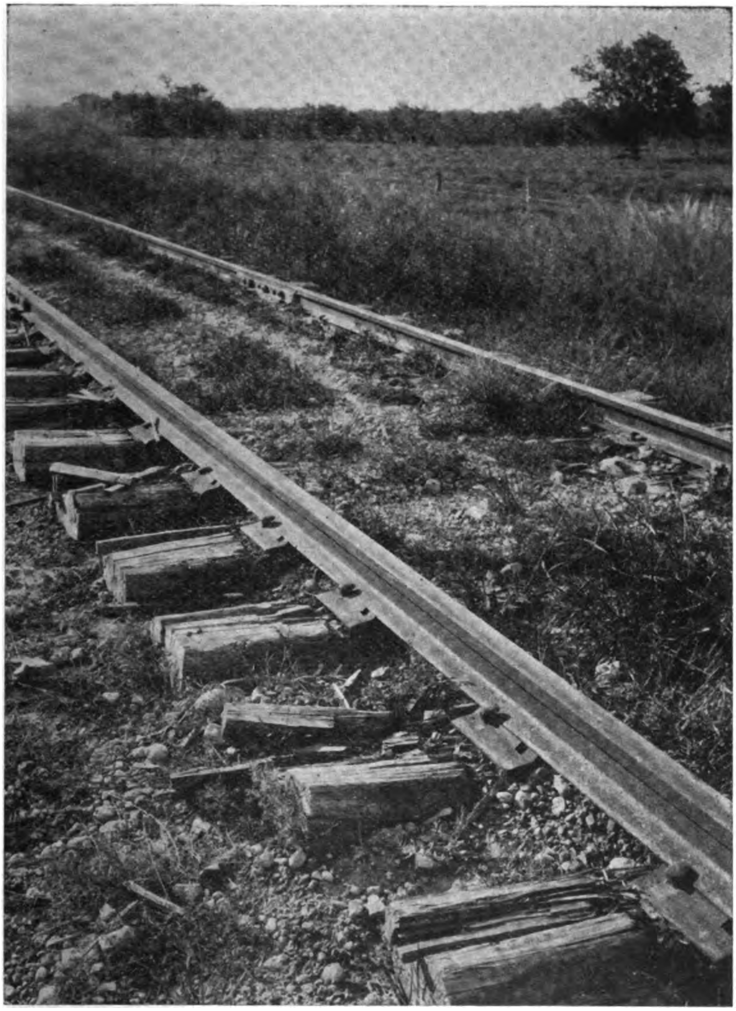


ABOVE. Photograph taken to show rail anchors. As ballast, ties, and anchors were all the same color it was necessary to mark the anchors with white chalk to bring them out clearly. If picture had been taken against the sun the anchors would have shown up fairly well without marking.

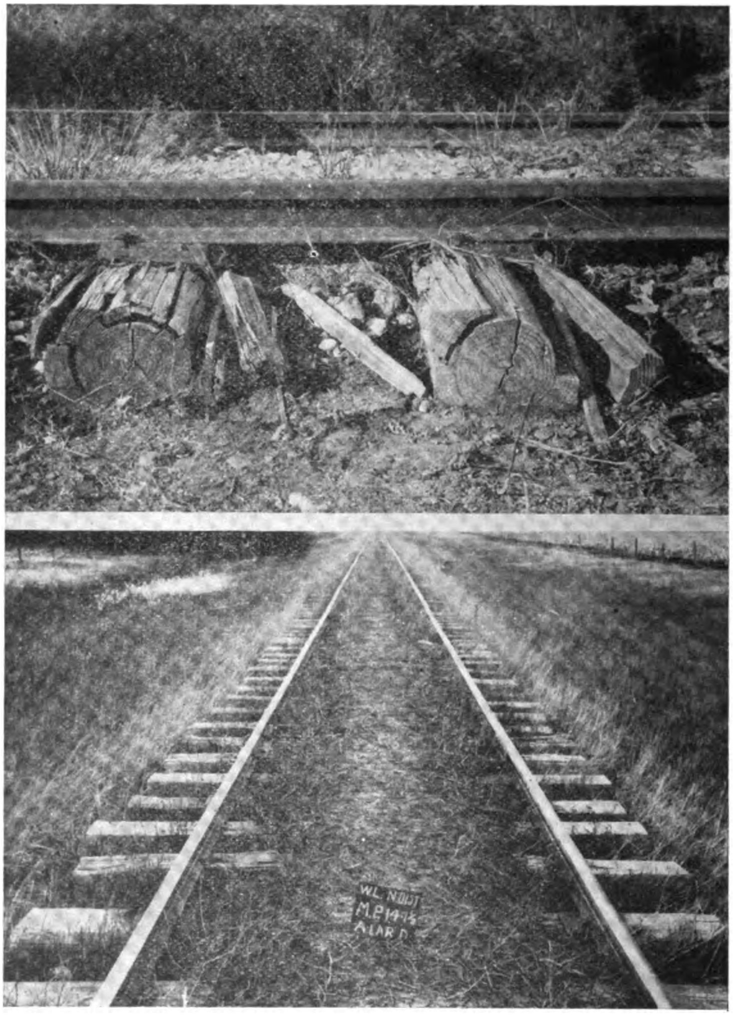
BELOW. Photograph of heavily treated jetty. Picture should have been taken when sun was shining directly on the object. Diaphragm stop 45, exposure 1/5 second.



Photographs showing condition of tie plates on ties. Upper picture taken with lens stopped down to 45, exposure 1 second, which gives sharp detail throughout. Lower picture taken with diaphragm wide open and 1/10 second exposure. Note how both foreground and background are out of focus.

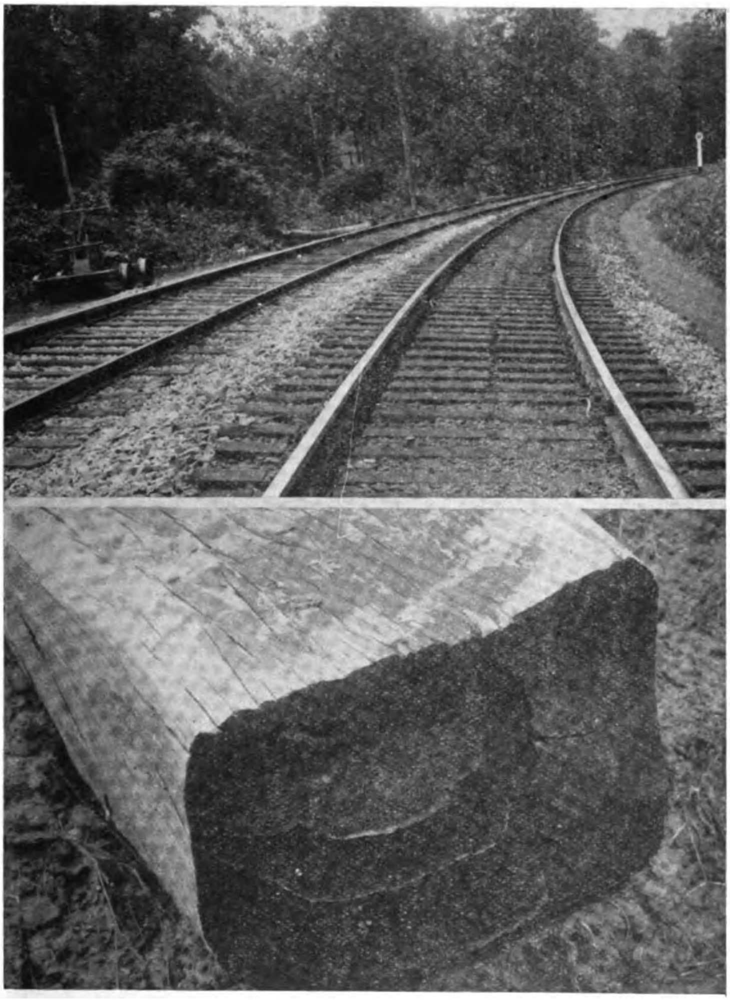


Photograph showing condition of ties. Diaphragm stop 32, exposure 1/5 second. Note that this photograph was taken towards the sun, which gave better detail in the shadows than if taken with the sun. This is good practice when taking track pictures unless the sun is down too low, and then the photograph should be taken from some other angle if possible.



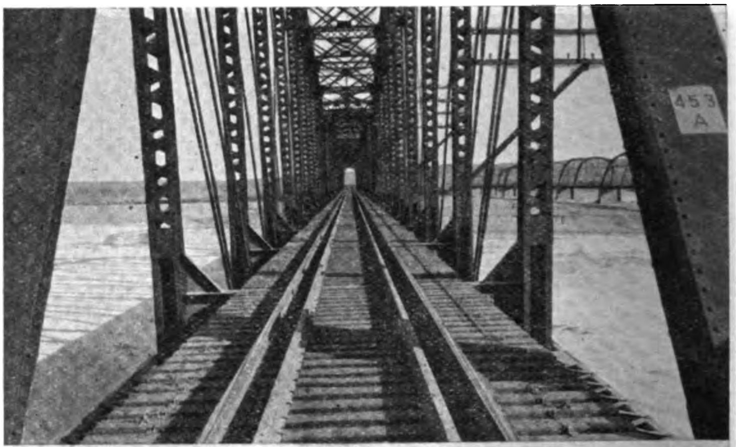
ABOVE. Photograph showing condition of ties. Sun shining at right angles. Note detail in shadows. Diaphragm stop 32, exposure 1/5 second.

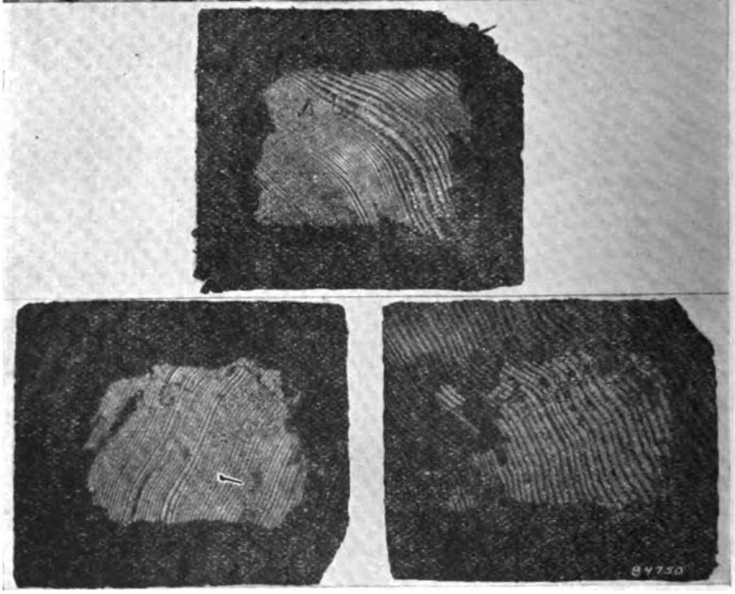
BELOW. Photograph taken facing sun, half obscured by the horizon at 7:00 p. m. Diaphragm stop 64, exposure 5 seconds. Note dark shadow in upper left hand corner made by holding piece of cardboard to shade lens from sun.



ABOVE. Photograph showing method of holding rails to ties, taken on an extremely cloudy day. Diaphragm stop 64, exposure 6 seconds. Better results would have been obtained if the sun had been shining in the center of the track and camera slightly facing it.

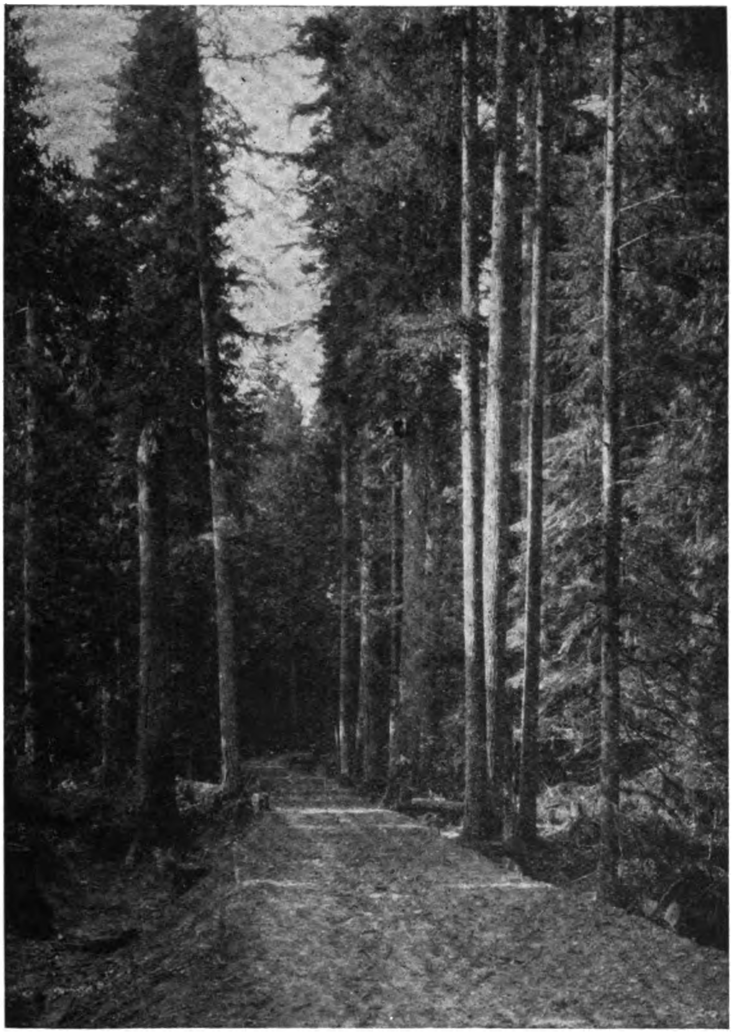
BELOW. Photograph of end of tie showing fungus growth. Taken late in the afternoon of a very cloudy day. A day with the sun shining would have given better results for this kind of picture. Diaphragm stop 32, exposure 3 seconds.



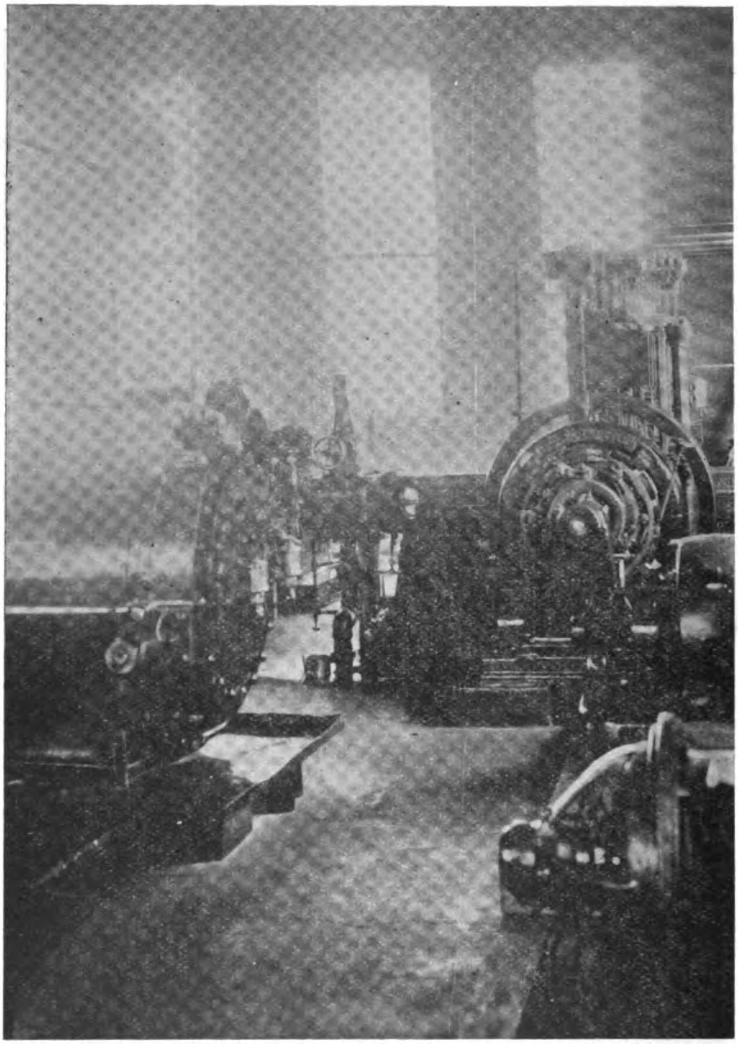


Above. Photograph showing tie spacers on sides of track. Note sharpness of bridge from one end to the other. Diaphragm stop 64, exposure 1 second. This photograph demonstrates clearly the necessity of closing the diaphragm to the limit when the foreground and distance are to be shown in detail.

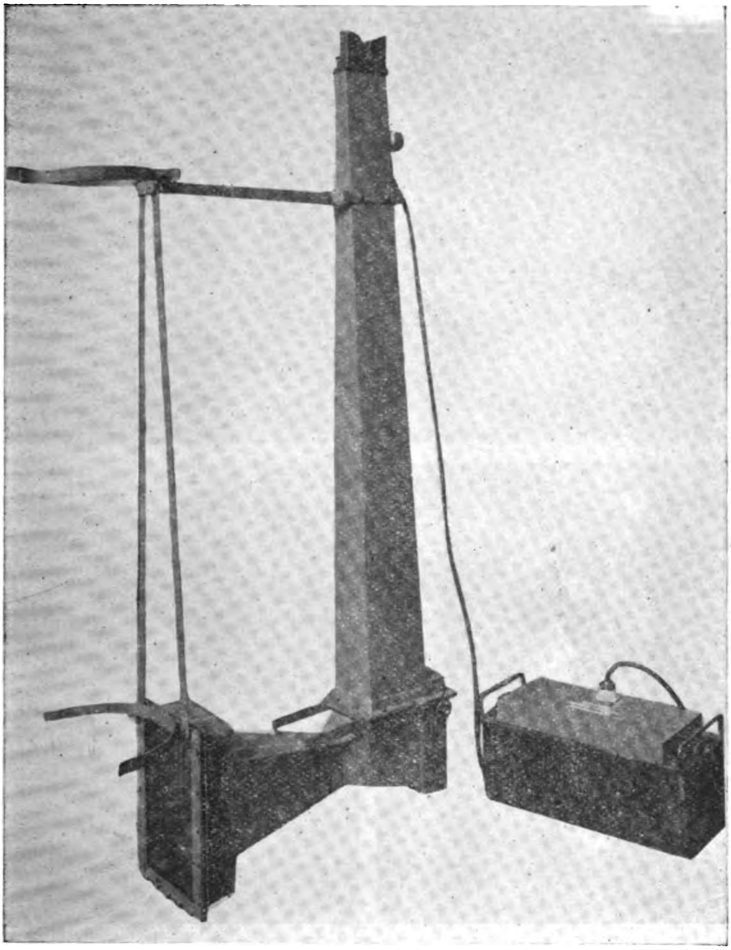
Below. Cross sectional view of perforated ties showing penetration of creosote. Camera should always be set at right angles when taking such pictures.



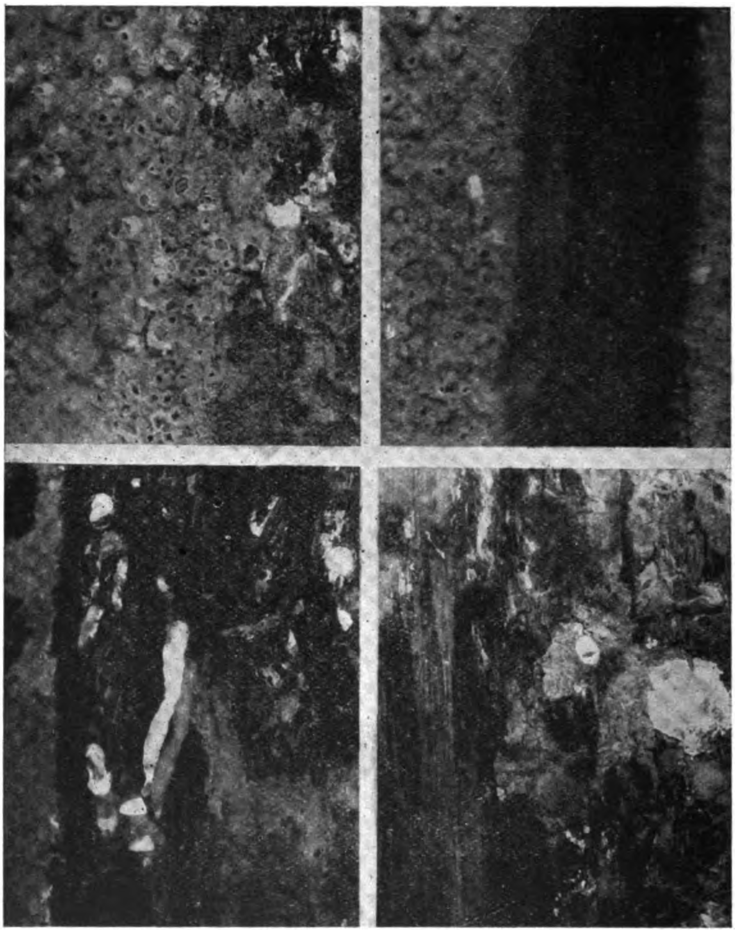
Photograph of Douglas fir trees. There was just enough sunlight coming through the clouds to give fine detail in the shadows. An ideal time to take forest views. Diaphragm stop 64, exposure 1 second.



Photograph of power plant showing effects of halation. The strong lights should have been eliminated and a flash light used. The results shown by this photograph are sure to happen when pictures are taken against strong light with long exposure.



An under-sea camera designed to take photographs of piling from 1 foot to 6½ feet under water. Light for taking photographs was furnished by four automobile lights in front of camera and attached to portable storage battery. Camera was lowered into water and clamped around the piling and by looking down the periscope all objects on the piling were clearly visible. The idea worked out should give excellent results where photographs under water are desired, as it is impossible to inspect the piling from above.



Upper left photograph taken with under-sea camera 3 feet under water showing condition of a section of treated piling completely covered with barnacles.

Upper right taken 6 feet under water showing rotten piling. This was also covered with barnacles.

Lower left taken 4½ feet under water showing portion of heavily treated piling, part of which was removed in chipping off shells and barnacles. Note the live teredo in center of picture.

Lower right taken 4 feet under water showing treated piling which had been cleaned off as barnacles and shells were very thick.

THE PRESIDENT: Mr. Strawn has certainly given us some good ideas on photography. Those of you who have any questions can ask them after the meeting adjourns.

An adjournment was then taken until Wednesday morning at ten o'clock.

WEDNESDAY MORNING SESSION

January 25, 1922

The meeting was called to order at ten A. M. by the Vice-President, Mr. Angier.

VICE-PRESIDENT ANGIER: We will change the program slightly and have the report now of Sub-Committee No. 7–1, Track.

MR. COOPER: In presenting this report I would say that the Committee feel especially indebted to the Forest Products Laboratory for the help and support they so cheerfully gave us. They have a mass of information and it was no small amount of labor for them to compile these completed tests. I would also say that the committee appointed by the A. R E. A. to that Association made the same recommendation which this Committee is making to you.

REPORT OF COMMITTEE NO. 7-1—SERVICE TEST RECORDS

To the Members of the American Wood-Preservers' Association:

The Committee was requested to get service test records of ties on the Northern Pacific; Chicago, Milwaukee, and St. Paul; Chicago and Northwestern; and Buffalo, Rochester, and Pittsburg Railways.

Reports of tie service test records were obtained covering the railroads mentioned, with the exception of the Buffalo, Rochester, and Pittsburg Railway Company, and so far as the Committee can find out no such records have been kept by this railroad.

Your Committee feels that instead of publishing each year a number of uncompleted tests, it would be of much more benefit to the membership of the Association if, in the future, nothing but completed tests be published. With this in view your Chairman, in company with Mr. C. F. Ford, of the Rock Island Railroad Company, visited the Forest Products Laboratory at Madison, Wisconsin, and was able to get compiled a series of 374 records on completed tests, which are appended to this report, and would recommend that they be published each year, adding to the list, year by year, such tests as have been completed during the preceding year. In presenting this series of completed tests your Committee would say:

Of the many tie service records on file at the Forest Products Laboratory those tests in which all the ties have been removed and upon which the average life can be computed have been summarized. On some of these tests the Forest Service has accurate detailed treating, setting, and inspection records from the very beginning. Other records contain data which have been sent to the Laboratory by various railroads. The accuracy of these records is, of course, measured by the care with which the treating, setting, and inspection data have been kept and reported by the respective roads. Some are naturally more accurate than others.

The tabulation includes 374 records on 38 species, and involves a total of over 923,000 ties. Various preservatives and methods of treatment are included, and the records on untreated ties afford an excellent opportunity to compare the durability of different species and of treated and untreated ties. The lack of value of some methods of treatment is evident, and the effectiveness of the standard preservatives and processes is clearly shown.

The Committee has refrained from detailed analyses of the tables, preferring to leave this to the reader. The data are capable of analysis in various ways, however, depending upon the character of the information desired, and they will warrant careful study.

It is believed that no other set of completed records has ever been published which are as comprehensive as these. The Committee wishes to emphasize the value of such records and to urge railway men to continue their excellent co-operation with the Forest Products Laboratory and to increase their efforts to turn in their data as promptly, accurately, and completely as possible.

S. D. COOPER, *Chairman*
G. M. DAVIDSON
G. C. DIXON
O. C. STEINMEYER
EARL STIMSON
W. P. WILTSEE
P. R. HICKS

RECORDS OF COMPLETED SERVICE TESTS OF TIES.

Species	Dimensions	Form	Preparation	Preservative	Process	Absorption Lbs. per cu. ft.	No. of ties	Railroad	Location	Date set	Track condition					Date 100% removed	Average life Years
											Tie plates Kind	Tie plates Size	Kind of spikes	Ballast	Traffic**		
Ash	----	----	-----	None	Untreated	----	56	C.B.& Q.R.R.	Lines East	1909	Yes	---	---	Cinders gravel	----	1916	4.7
Beech	----	----	-----	"	"	----	109	" "	" "	1909	"	---	Cut	Cinders gravel clay	----	1920	4.3
"	----	Sawed	-----	"	"	----	100	G.C.& S.F.Ry.	Beaumont, Texas	1902	None	---	"	Sand	Heavy	1906	3.0
"	----	----	-----	Zinc chloride	Burnett	----	13835	Penn.R.R.	Western Division	1902	---	---	---	----	----	1917	8.9
"	----	----	-----	" "	"	----	9937	" "	" "	1901	---	---	---	----	----	1916	11.1
Beech	----	Sawed	-----	Zinc chloride	Burnett	----	99	G.C.& S.F.Ry.	Beaumont, Texas	1902	None	---	Cut	Sand	Heavy	1914	10.5
"	----	----	-----	Zinc creosote	Allardyce	0.24 zinc 3.0 creo.	80	" "	" "	"	"	---	"	"	"	"	8.9
"	----	Sawed	-----	" "	----	0.3 zinc*	80	" "	" "	"	"	---	"	"	"	1908	8.0
"	----	Hewed	-----	Zinc tannin	Wellhouse	0.87 zinc	100	" "	" "	"	"	---	"	"	"	1914	10.5
"	----	----	-----	None	Untreated	----	89	C.B.& Q.R.R.	Lines East	1909	Partly	---	"	Cinders gravel clay	----	"	3.1
Cedar	----	----	-----	None	Untreated	----	1000	C.& N.W.Ry.	Elmhurst, Ill.	1903	50% Wolhaupter 50% without	4x6	---	Stone	----	1918	13.3
	6"x8"x8'	Hewed	Seasoned	"	"	----	2001	C.R.I.& P.Ry.	Vinton, Ia.	1898	Yes	8x7½	Cut	Gravel	4,745000	1917	17.2
Cottonwood	----	----	-----	"	"	----	56	C.B.& Q.R.R.	Lines East	1909	Partly	---	"	Cinders gravel clay	----	1915	3.1
Cypress	----	Hewed	-----	"	"	----	282	G.H.& S.A.Ry.	Watkins Cut Off	1898	Yes	---	---	Dirt	----	1918	17.3
"		"	-----	"	"	----	568	" "	" " "	"	None	---	---	"	----	"	17.3
Cypress	----	Hewed	-----	None	Untreated	----	73	G.H.& S.A.Ry.	Watkins Cut Off	1898	None	---	---	Earth	----	1918	17.6
"	----	Sawed	-----	"	"	----	654	" "	" " "	"	"	---	---	"	----	1916	14.9
"	----	"	-----	"	"	----	374	" "	" " "	1898	Yes	---	---	"	----	"	14.9
"	----	"	-----	"	"	----	641	" "	" " "	"	"	---	---	Rock	----	1914	14.9
Elm	----	----	-----	"	"	----	88	C.B.& Q.R.R.	Lines East	1909	Partly	---	Cut	Cinders gravel clay	----	1920	5.6
Fir, Douglas (Coast)	7"x9"x8'	Sawed	Green	None	Untreated	----	264	Northern Pacific Ry.	Maywood, Wash.	1906	Sellers	---	Cut	Gravel	Heavy	1917	8.1
" " "	"	"	Seasoned	"	"	----	350	" " "	" "	1906	"	---	"	"	"	"	8.3
" " "	"	"	Green	"	"	----	100	" " "	" "	1906	"	---	Screw & cut	"	"	"	8.3
" " "	"	"	Seasoned	"	"	----	100	" " "	" "	1906	"	---	Screw & cut	"	"	"	8.3
" " "	"	"	"	"	"	----	58	" " "	" "	1906	None	---	Screw	"	"	"	7.7
Fir, Douglas (Coast)	7"x9"x8'	Sawed	Seasoned	None	Untreated	----	96	Northern Pacific Ry.	Maywood, Wash.	1906	Sellers	---	Screw	Gravel	Heavy	1917	8.4
" " "	"	"	"	"	"	----	91	" " "	" "	"	"	---	Screw & cut	"	"	"	6.8
" " "	"	"	"	"	"	----	99	" " "	" "	"	None	---	Cut	"	"	"	7.8
" " "	"	"	Green	"	"	----	100	" " "	" "	"	"	---	"	"	"	1916	7.3
" " "	"	"	Seasoned	"	"	----	264	" " "	" "	"	Sellers	---	"	"	"	1917	8.4
" " "	"	"	Partly seasoned	Zinc chloride	Burnett	0.243	217	Southern Pacific Ry.	Various	1898	Servis & Wolhaupter	---	"	Stone, gravel earth	"	1908	11.3
Fir, Douglas (Coast)	7"x9"x8'	Sawed	Partly seasoned	Zinc chloride	Burnett	0.243	4048	Southern Pacific RR.	Various	1896	Servis & Wolhaupter	---	---	Stone, gravel earth	Heavy	1909	10.9
" " "	"	"	" "	" "	"	"	1941	" " "	"	1897	"	---	---	"	"	1910	10.7
" " "	"	"	" "	" "	"	"	20636	" " "	"	1898	"	---	---	"	"	1912	10.9
" " "	"	"	" "	" "	"	"	12961	" " "	"	1899	"	---	---	"	"	1918	10.8
" " "	"	"	" "	" "	"	"	28144	" " "	"	1900	"	---	---	"	"	"	9.2
Fir, Douglas (Coast)	7"x9"x8'	Sawed	Partly seasoned	Zinc chloride	Burnett	0.243	43681	Southern Pacific RR.	Various	1901	Servis & Wolhaupter	---	---	Stone, gravel earth	Heavy	1916	10.4
" " "	"	"	" "	" "	"	"	38963	" " "	"	1905	"	---	---	"	"	"	10.8
" " "	"	"	" "	" "	"	"	48478	" " "	"	1906	"	---	Cut	"	"	1917	9.7
" " "	"	"	" "	" "	"	"	44689	" " "	"	1908	"	---	"	"	"	"	7.2

*Followed by heavy creosote treatment.
**Figures indicate tons per year.

RECORDS OF COMPLETED SERVICE TESTS OF TIES

Species	Dimensions	Form	Preparation	Preservative	Process	Absorption lb. per cu. ft.	No. of ties	Railroad	Location	Date set	Track condition: Tie plates Kind	Track condition: Tie plates Size	Track condition: Kind of Spikes	Track condition: Ballast	Track condition: Traffic	Date removed	Average life Years
Fir, Douglas (mountain)	7" x 9" x 8'	Hewed	Green	None	Untreated	---	95	Northern Pacific Ry.	Plains, Montana	1907	Sellers & Wolhaupter	--	Screw & cut	Gravel	Heavy	1916	7.6
"	"	"	"	"	"	---	94	"	"	1907	"	--	Cut	"	"	1916	7.6
"	"	"	"	"	"	---	100	"	"	1907	Sellers	--	Screw & cut	"	"	1916	7.8
"	"	"	"	"	"	---	91	"	"	1907	"	--	Cut	"	"	1915	7.6
"	"	"	"	"	"	---	90	"	"	1907	"	--	Screw	"	"	1915	7.7
Fir, Douglas (mountain)	7" x 9" x 8'	Hewed	Green	None	Untreated	---	92	Northern Pacific Ry.	Plains, Montana	1907	Sellers	--	Cut	Gravel	Heavy	1916	7.6
"	"	"	"	"	"	---	98	"	"	1907	Wolhaupter	--	"	"	"	1916	7.6
"	"	"	"	"	"	---	90	"	"	1907	Sellers	--	"	"	"	1916	7.8
"	"	"	"	"	"	---	90	"	"	1907	"	--	"	"	"	1916	7.6
"	"	"	"	"	"	---	90	"	"	1907	"	--	Screw & cut	"	"	1916	7.7
Fir, Douglas (mountain)	7" x 9" x 8'	Hewed	Green	None	Untreated	---	90	Northern Pacific Ry.	Plains, Montana	1907	Sellers	--	Screw	Gravel	Heavy	1916	7.7
"	"	"	"	"	"	---	89	"	"	1907	N. P.	--	Cut	"	"	1916	7.6
Gum	---	"	Seasoned before & after treating	---	Vulcanized	---	100	Norfolk Southern R. R.	Norfolk, Va.	1897	--	--	--	---	--	1906	8.8
"	---	Sawed	"	---	"	---	100	"	"	1897	--	--	--	---	--	1906	4.8
"	---	"	"	Zinc tannin	Wellhouse	1.36	100	"	"	1897	Servis	--	--	---	--	1918	14.3
Gum	---	Sawed	Seasoned before & after treating	Zinc tannin	Wellhouse	4.2	100	Norfolk Southern R. R.	Norfolk, Va.	1897	Servis	--	--	---	--	1918	16.3
Gum, red	---	--	---	None	Untreated	---	83	C. B. & Q. R. R.	Lines West	1909	Yes	--	Cut	Cinders, gravel, clay	--	1919	4.6
" "	---	--	---	"	"	---	98	"	" East	1909	Partly	--	"	"	--	1918	3.7
" , tupelo	----	--	---	"	"	---	88	"	" "	1909	"	--	"	"	--	1916	2.9
Hemlock	6" x 8" x 8'	Hewed	---	Creosote	---	---	400	N. Y. N. H. & H. R. R.	Medway, Mass.	1880	--	--	"	Gravel	--	1912	20.0
Hemlock	---	--	---	None	Untreated	---	88	C. B. & Q. R. R.	Lines East	1909	Partly	--	Cut	Cinders, gravel, clay	--	1916	4.2
"	---	Hewed	---	"	"	---	101	G. C. & S. F. Ry.	Beaumont, Texas	1902	None	--	"	Sand	Heavy	1904	2.0
"	---	--	---	Zinc chloride	Burnett	---	200	Pennsylvania R. R.	Western Div.	1892	--	--	--	---	--	1907	10.9
"	---	--	---	" "	"	---	698	" " "	Chicago "	1896	--	--	--	---	--	1908	11.4
"	---	--	---	" "	"	---	8909	" " "	Western "	1897	--	--	--	---	--	1916	10.2
Hemlock	---	--	---	Zinc chloride	Burnett	---	4786	Pennsylvania R. R.	Chicago Div.	1897	--	--	--	---	--	1911	10.1
"	---	--	---	" "	"	---	438	" " "	Western Div.	1898	--	--	--	---	--	1915	9.7
"	---	--	---	" "	"	---	279	" " "	Chicago Div.	1898	--	--	--	---	--	1910	8.3
"	---	--	---	" "	"	---	1000	" " "	" "	1899	--	--	--	---	--	1913	11.6
"	---	--	---	" "	"	---	1048	" " "	Western "	1899	--	--	--	---	--	1916	9.7
Hemlock	---	--	---	Zinc chloride	Burnett	---	521	Pennsylvania R. R.	Western Div.	1900	--	--	--	---	--	1915	8.9
"	---	--	---	" "	"	---	713	" " "	" "	1898	--	--	--	---	--	1915	9.2
"	---	Hewed	---	Zinc creosote	Allardyce	0.24 zinc 3.0 creo.	50	G. C. & S. F. R. R.	Beaumont, Texas	1902	None	--	Cut	Sand	Heavy	1911	9.0
"	---	"	---	Zinc tannin	Wellhouse	0.64	100	" " " " " " "	" "	1902	--	--	---	---	--	1914	11.1
"	---	--	---	" "	"	---	200	Pennsylvania R. R.	Hanna	1892	--	---	---	---	--	1906	10.7
Hemlock	---	Hewed	---	Zinc tannin	Wellhouse	---	11990	C. & N. W. Ry.	Belle Plaine & Miami, Ia.	1905 & 1906	Wolhaupter	--	---	---	--	1913	12.0
"	7" x 9" x 8'	"	Green	None	Untreated	---	100	Northern Pacific Ry.	Haywood, Wash.	1906	Sellers	--	Cut	Gravel	Heavy	1919	7.3
"	"	Sawed	"	"	"	---	103	" " "	" "	1906	None	--	"	"	"	1915	7.3
Juniper	---	Hewed	Seasoned	Creosote	Full cell	8.0	75	Norfolk Southern R. R.	Norfolk, Va.	1897	90% tie plated	--	---	---	--	1918	20.1
"	---	"	"	None	Untreated	---	80	" " " "	" "	--	--	--	---	---	--	1908	8.4

RECORDS OF COMPLETED SERVICE TESTS OF TIES

Species	Dimensions	Form	Preparation	Preservative	Process	Absorption Lbs. per cu. ft.	No. of ties	Railroad	Location	Date set	Track Conditions: Tie plates Kind	Tie plates Size	Kind of spikes	Ballast	Traffic	Date 100% removed	Average life Years
Juniper	---	Hewed	Seasoned	None	Untreated	---	100	Norfolk Southern R. R.	Norfolk, Va.	1897	--	--	--	--	--	1917	13.2
"	---	"	"	"	"	---	200	" " " "	" "	1897	--	--	--	--	--	1917	13.8
"	---	"	"	"	"	---	100	" " " "	" "	1897	--	--	--	--	--	1917	13.7
"	---	"	"	"	"	---	120	" " " "	" "	1897	--	--	--	--	--	1916	13.4
"	---	"	"	"	"	---	100	" " " "	" "	1897	--	--	--	--	--	1916	13.4
Juniper	---	Hewed	Seasoned	None	Untreated	---	100	Norfolk Southern R. R.	Norfolk, Va.	1897	Lugs & Dips	--	--	--	--	1910	13.6
"	---	"	"	"	"	---	100	" " " "	" "	1897	Felt	--	--	--	--	1910	13.1
"	---	"	"	"	"	---	100	" " " "	" "	1897	--	--	--	--	--	1910	13.8
"	---	"	"	"	"	---	128	" " " "	" "	1897	Servis	--	--	--	--	1914	11.8
Larch, western	7" x 9" x 8'	"	"	"	"	---	90	Northern Pacific R. R.	Plains, Montana	1907	Wolhaupter	--	Cut	Gravel	Heavy	1915	7.2
Larch, western	7" x 9" x 8'	Hewed	Seasoned	None	Untreated	---	90	Northern Pacific R. R.	Plains, Montana	1907	Sellers	--	Cut	Gravel	Heavy	1916	7.6
" "	"	"	"	"	"	---	90	" " " "	" "	1907	"	--	Cut	"	"	1915	7.3
" "	"	"	"	"	"	---	90	" " " "	" "	1907	"	--	Screw & cut	"	"	1916	7.4
" "	"	"	"	"	"	---	90	" " " "	" "	1907	"	--	Screw	"	"	1916	7.8
" "	"	"	"	"	"	---	91	" " " "	" "	1907	S. P.	--	Cut	"	"	1916	7.3
Larch, western	7" x 9" x 8'	Hewed	Seasoned	None	Untreated	---	92	Northern Pacific R. R.	Plains, Montana	1907	Sellers	--	Screw	Gravel	Heavy	1916	7.9
" "	"	"	"	"	"	---	91	" " " "	" "	1907	"	--	Screw & cut	"	"	1916	7.4
" "	"	"	Green	"	"	---	91	" " " "	" "	1907	"	--	Cut	"	"	1916	7.4
" "	"	"	"	"	"	---	90	" " " "	" "	1907	"	--	"	"	"	1916	7.5
" "	"	"	"	"	"	---	91	" " " "	" "	1907	Wolhaupter	--	"	"	"	1916	7.2
Larch, western	7" x 9" x 8'	Hewed	Green	None	Untreated	---	96	Northern Pacific R. R.	Plains, Montana	1907	Wooden & Wolhaupter	--	Screw & cut	Gravel	Heavy	1916	6.9
Maple, hard	---	---	---	"	"	---	52	C. B. & Q. R. R.	Lines East	1909	Partly	--	Cut	Cinders, gravel, clay	--	1915	5.8
" "	6" x 7" x 8'	Hewed	Green	"	"	---	100	C. & S. R. Ry.	Calamus, Ia.	1914	None	--	"	Stone	--	1919	---
" , soft	---	---	---	"	"	---	67	C. B. & Q. R. R.	Lines East	1909	Partly	--	"	Cinders, gravel, clay	--	1920	6.4
Oak, black	6" x 8" x 8'	---	---	Hasselmann, salts	Hasselmann	---	110	G. C. & S. F. R. R.	Beaumont, Texas	1903	None	--	"	Sand	Heavy	1908	5.8
Oak, black	6" x 8" x 6'	---	Steamed	Zinc creosote	---	---	76	G. C. & S. F. R. R.	Beaumont, Texas	1903	None	--	Cut	Sand	Heavy	1904	1.8
" "		---	"	" "	Allardyce	0.84 zinc 3.0 creo.	60	"	" "	1903	"	--	"	"	"	1914	9.2
" , pin	---	---	Seasoned	None	Untreated	---	484	B. & O. R. R.	Medora, Ind.	1904	--	--	--	--	--	1916	7.7
" , red	---	---	"	J. M. Long's liquid	---	0.136	50	Illinois Central	Greenville, Miss.	1910	Economy 80% ties dated	--	--	Dirt	--	1916	4.7
" "	---	---	---	None	Untreated	---	60	C. B. & Q. R. R.	Lines West	1909	Yes	--	Cut	Cinders, gravel, clay	--	1916	6.0
Oak, red	---	---	---	None	Untreated	---	80	C. B. & Q. R. R.	Lines West	1906	on curves	--	Cut	--	--	1920	6.8
" "	---	---	---	"	"	---	93	G. C. & S. F. R. R.	Beaumont, Texas	1903	None	--	"	Sand	Heavy	1911	8.0
" "	---	---	---	"	"	---	1900	Pennsylvania R. R.	Scio, Ohio	1907	Flat	6 x 9	"	Stone	--	1916	6.7
" "	---	---	---	Wood tar creosote	---	---	250	" " "	Harrisburg & Williamsport	1906	--	--	"	--	--	1914	7.0
" "	---	---	---	" " "	---	---	66	" " "	Baltimore, Md.	1906	--	--	--	--	--	1914	8.3
Oak, red	---	---	---	Wood tar creosote	---	---	180	Pennsylvania R. R.	Camden, N. J.	1906	--	--	--	--	--	1914	4.0
" "	---	---	---	" " "	Dipped	---	289	" " "	N. Y. & Philadelphia	1906	--	--	--	--	--	1914	5.7
" "	---	---	---	" " "	"	---	297	" " "	Camden, N. J.	1906	--	--	--	--	--	1914	6.3
" "	---	---	---	" " "	"	---	250	" " "	N. Y. & Philadelphia	1906	--	--	--	--	--	1914	4.8
" "	---	---	---	" " "	"	---	591	" " "	Camden, N. J.	1906	--	--	--	--	--	1914	5.5

RECORDS OF COMPLETED SERVICE TESTS OF TIES.

Species	Dimensions	Form	Preparation	Preservative	Process	Absorption Lbs. per cu. ft.	No. of ties	Railroad	Location	Date set	Track condition: Tie plates: Kind	Track condition: Tie plates: Size	Track condition: Kind of spikes	Track condition: Ballast	Track condition: Traffic**	Date 100% removed	Average life Years
Oak, red	---	---	---	Wood tar creosote	Dipped	---	3910	Penn. RR.	Camden, N. J.	1896	---	---	---	---	---	1914	6.4
" "	---	---	---	Zinc chloride	Burnett	---	186	" "	Pittsburg, Pa.	1897	---	---	---	---	---	1916	10.7
" "	7"x8"x8'	Hewed	Seasoned	Zinc creosote	Low pressure	---	380	G.H. & S.A.Ry.	Louisiana	1906	I.& W.	---	Cut	Gravel	---	1917	10.8
Oak, white	6"x8"x8'	---	---	Barschall salts	Hasselmann	---	196	G.C. & S.F.Ry.	Beaumont, Texas	1902	None	---	"	Sand	Heavy	1914	6.8
" "	"	---	---	None	Untreated	---	"	" "	" "	"	"	---	"	"	"	"	6.8
Oak, white	---	---	---	None	Untreated	---	8400	Illinois Central	Memphis, Tenn.	1901	---	---	---	---	---	1909	4.5
" "	7"x7"x8'.6"	Hewed	---	"	"	---	137000	B. & O. RR.	Washington Terminal	1904	Flat bottom	---	Cut	Stone & cinders	1440000	1918	8.8
" "	---	"	Seasoned	"	"	---	300	Norfolk & Southern RR.	Norfolk, Va.	1897	---	---	---	---	---	1910	8.4
" "	9"x8"x8'.6"	Sawed	---	"	"	---	48725	P.S. & N. RR.	New York	1902	Wolhaupter	6x9½	Cut	Slag	4000000	1920	12.9
" "	---	---	---	Wood tar creosote	---	---	104	Penn. RR.	N.Y. & Philadelphia	1892	---	---	---	---	---	1914	7.0
Oak, white	---	---	---	Wood tar creosote	Brush	---	551	Penn. RR.	Camden & Trenton	1894	---	---	---	---	---	1914	8.8
" "	---	---	---	" " "	"	---	204	" "	Baltimore, Md.	1897	---	---	---	---	---	"	9.0
" "	---	---	---	" " "	"	---	396	" "	" "	1897	---	---	---	---	---	"	8.0
" "	---	---	---	" " "	"	---	597	" "	" "	'97-8	---	---	---	---	---	"	9.0
" "	---	---	---	" " "	"	---	72	" "	" "	1898	---	---	---	---	---	"	"
Oak, white	---	---	---	Wood tar creosote	Brush	---	541	Penn. RR.	Baltimore, Md.	1897	---	---	---	---	---	1914	9.8
" "	---	---	---	" " "	"	---	238	" "	" "	1899	---	---	---	---	---	"	10.0
" "	---	---	---	" " "	Dipped	---	478	" "	N.Y. & Philadelphia	1897	---	---	---	---	---	"	4.0
" "	---	---	---	" " "	"	---	70	" "	" "	1898	---	---	---	---	---	"	5.8
" "	---	---	---	" " "	"	---	348	" "	" "	1896	---	---	---	---	---	"	4.0
Oak, white	---	---	---	Wood tar creosote	Dipped	---	600	Penn. RR.	Camden & Trenton	1896	---	---	---	---	---	1914	5.5
" "	---	---	---	" " "	"	---	86	" "	" "	1897	---	---	---	---	---	"	5.0
" "	6"x8"x8'	---	Seasoned, Steamed	Zinc chloride	Burnett	0.26	100	G.C. & S.F.Ry.	Beaumont, Texas	1902	None	---	Cut	Sand	Heavy	"	10.8
" "	"	---	"	" "	"	0.36	100	" "	" "	"	"	---	"	"	"	1909	6.8
" "	"	---	Steamed	Zinc creosote	---	0.5 zinc*	107	" "	" "	"	"	---	"	"	"	1906	2.8
Pine, Colorado	---	---	---	Zinc tannin	Wellhouse	---	80	A.T. & S.F. Ry.	La Junta, Colo.	1882	---	---	---	---	---	1897	11.8
Pine, loblolly	---	---	---	Barschall salts	Hasselmann	---	99	G.C. & S.F. Ry.	Beaumont, Texas	1902	None	---	Cut	Sand	Heavy	1906	3.5
" "	---	---	---	Beaumont oil & zinc chloride	---	0.28	80	" "	" "	1902	"	---	"	"	"	1911	9.0
" "	7"x8"x8'x6"	Sawed & Hewed	Seasoned	Creosote	Full cell	8 - 10	2743	Penn. R.R.	Wooster, Ohio	1910	Flat bottom	7x9 to 9x13½	Cut & screw	Stone	20,000,000	1918	6.4
" "	---	---	"	J.M.Lenz's liquid	---	0.826	174	Illinois Central	Greenville, Miss.	1910	Economy 80%	---	---	Dirt	---	1916	5.5
Pine loblolly	---	---	Seasoned	Spirittine	---	3.5	100	G.C. & S.F. Ry.	Beaumont, Texas	1902	None	---	Cut	Sand	Heavy	1911	8.6
" "	---	---	---	None	Untreated	---	61	C.B. & Q. R. R.	Lines West	1909	Yes	---	"	Cinders, gravel, clay	---	1920	8.8
" "	---	---	---	"	"	---	100	G.C. & S.F. Ry.	Beaumont, Texas	1902	None	---	"	Sand	Heavy	1904	2.0
" "	6"x9"x8'	Hewed	Green	"	"	---	100	C. & N. W. Ry.	Calamus, Ia.	1914	Sellers	6--	"	Gravel	---	1920	6.0
" "	---	---	---	Zinc chloride	Burnett	0.36	100	G. C. & S. F. Ry.	Beaumont, Texas	1902	None	---	"	Sand	Heavy	1911	9.0
Pine, loblolly	---	---	---	Zinc tannin	Wellhouse	0.33 zinc	99	G. C. & S. F. Ry.	Beaumont, Texas	1902	None	---	Cut	Sand	Heavy	1914	8.0
Pine, lodgepole	---	---	---	Zinc chloride	Burnett	---	348,000	Union Pacific R. R.	Wyoming	1886	---	---	---	---	---	1897	9.0
Pine, longleaf	6"x8"x8'	---	---	Barschall salts	Hasselmann	---	100	G. C. & S. F. Ry.	Beaumont, Texas	1902	None	---	Cut	Sand	Heavy	1914	6.0
" "	---	Hewed	---	Beaumont oil	---	8.0	100	" "	" "	"	"	---	"	"	"	1911	8.0
" "	---	---	---	Beaumont oil & zinc chloride	---	---	100	" "	" "	"	"	---	"	"	"	1914	4.0

*Followed by heavy creosote treatment

**Figures indicate tons per year

RECORDS OF COMPLETED SERVICE TESTS OF TIES

Species	Dimensions	Form	Preparation	Preservative	Process	Absorption lbs. per cu. ft.	No. of ties	Railroad	Location	Date set	Track conditions: Tie plates Kind	Tie plates Size	Kind of spikes	Ballast	Traffic	Date 100% removed	Average life Years
Pine, longleaf	---	--	---	Spirittine	---	3.3	100	G.C. & S.F. Ry.	Beaumont, Texas	1902	None	--	Cut	Sand	Heavy	1914	10.0
" "	7"x9"x8½'	Hewed	Seasoned	None	Untreated	---	80	A.C.L. R.R.	Waycross, Ga.	1915	Flange	--	"	Gravel	---	1920	4.0
" "	6"x8"x8'	Sawed	---	"	"	---	2100	C.M. & St.P. Ry.	Rio, Wisconsin	1899	None	--	"	"	Heavy	1917	12.1
" "	"	--	---	"	"	---	96	G.C. & S.F. Ry.	Beaumont, Texas	1902	"	--	"	Sand	"	1911	8.5
" "	7"x9"x8'	Sawed	---	"	"	---	484	G.H. & S.A. Ry.	Bay View & San Leon, Tex.	1906	"	--	--	--	---	1917	4.7
Pine, longleaf	7"x9"x8'	Sawed	---	None	Untreated	---	868	G.H. & S.A. Ry.	Bay View & San Leon, Tex.	1906	Glendon	--	--	--	---	1914	4.1
" "	"	"	---	"	"	---	184	"	"	1905	---	--	Screw	--	---	1916	4.0
" "	---	--	---	"	"	---	180	"	Watkins cut off	1896	Yes	--	--	Rock	---	1914	9.0
" "	---	--	---	"	"	---	717	"	"	1896	"	--	--	Earth	---	1914	9.0
" "	---	--	---	"	"	---	769	"	"	1896	---	--	--	"	---	1914	9.0
Pine, longleaf	6"x7"x8'	Hewed	Green	None	Untreated	---	100	C. & N. W. Ry.	Calamus, Ia.	1914	Sellers	--	Cut	Stone	----	1920	6.0
" "	6"x10"x8-1/3'	Hewed	---	Zinc chloride	Burnett	---	87	N.Y. N.H. & H. R.R.	Bomayton, Conn.	1901	Yes	6 x 8	"	"	---	1914	13.0
" "	"	"	---	" "	"	---	68	"	" "	1901	"	"	"	"	---	1916	14.4
" "	"	"	---	" "	"	---	67	"	" "	1901	"	"	"	"	---	1916	14.8
" "	6"x8"x8'	--	Steamed	Zinc creosote	---	---	80	G.C. & S.F. Ry.	Beaumont, Texas	1902	None	--	"	Sand	Heavy	1914	9.7
Pine, miscellaneous	---	--	Seasoned	Zinc tannin	Wellhouse	---	86	D. & I. R. R. R.	---	1890	---	--	Cut	Gravel	Light	1906	15.0
Pine, sap	7"x9"x8'	Hewed	"	Zinc chloride	Burnett	0.4122	334	G.H. & S.A. Ry.	Bay View & San Leon, Tex.	1906	---	--	Screw	--	---	1914	5.4
" "	"	"	"	" "	"	0.4122	384	"	"	1906	None	--	--	--	---	1916	5.6
" "	"	"	"	" "	"	0.4122	335	"	"	1906	Glendon	--	--	--	---	1917	6.6
" "	7"x8"x8'	"	---	Zinc creosote	Allardyce	0.27 zinc 4.49 creo.	187	"	Galveston, Texas	1906	None	--	--	--	---	1916	8.8
Pine, sap	7"x8"x8	Hewed	---	Zinc creosote	Allardyce	0.27 zinc 4.49 creo.	186	G.H. & S.A. Ry.	Galveston, Texas	1906	Glendon	--	Screw	--	---	1916	10.4
" "	"	"	---	" "	"	"	780	"	" "	1906	"	--	"	--	---	1917	11.1
Pine, shortleaf	---	Sawed	---	Barschall salts	Hasselmann	---	90	G.C. & S.F. Ry.	Beaumont, Texas	1902	None	--	Cut	Sand	Heavy	1914	4.9
" "	---	"	---	None	Untreated	---	100	"	" "	1902	"	--	"	"	"	1906	3.4
" "	---	"	---	Zinc chloride	Burnett	---	100	"	" "	1902	"	---	"	"	"	1914	10.0
Pine, shortleaf	---	--	Green	Zinc chloride	Burnett	0.55	6048	Southern Pacific R.R.	Glidden Dist.	1885	--	--	--	Gravel	---	1898	6.8
" "	---	--	"	" "	"	0.55	41691	" " "	San Antonio Dist.	1891	--	--	--	"	---	1898	6.2
" "	---	--	"	" "	"	0.55	15644	" " "	Del Rio Dist.	1891	--	--	--	"	---	1898	5.9
" "	---	--	"	" "	"	0.55	2507	" " "	Sanderson Dist.	1891	--	--	--	"	---	1898	6.7
" "	---	--	"	" "	"	0.55	12090	" " "	Valentine Dist.	1891	--	--	--	Fine gravel	---	1898	7.0
Pine, shortleaf	---	--	Green	Zinc chloride	Burnett	0.55	13397	Southern Pacific R.R.	El Paso District	1891	--	--	--	---	---	1898	7.5
Pine, southern yellow	---	--	---	Avenarius carbolineum	---	---	84	G.C. & S.F. Ry.	Beaumont, Texas	1906	None	--	Cut	Sand	Heavy	1914	8.0
" " "	---	Hewed	Seasoned	---	Vulcanized	---	100	Norfolk & Southern R.R.	Norfolk, Va.	1897	--	--	--	---	---	1899	2.0
" " "	---	Sawed	"	---	"	---	100	" " "	" "	1897	--	--	--	---	---	1900	4.8
" " "	---	--	"	None	Untreated	---	75	G.H. & S.A. R.R.	Lafayette & Scott, La.	1907	Wolhaupter	--	Cut	Gravel	---	1914	2.7
Pine, southern yellow	---	--	---	Creosote-resin	Creo-resinate	---	500	Penn. R. R.	Altoona, Pa.	1901	--	--	--	---	---	1914	9.0
" " "	---	--	---	" "	"	---	250	" "	Pittsburg, Pa.	1901	--	--	--	---	---	1914	7.5
" " "	---	--	---	" "	"	---	125	" "	Seaside, N. J.	1901	--	--	--	---	---	1914	9.0
" " "	---	---	--	" "	"	---	125	" "	"	1901	--	---	--	---	---	1914	10.0
" " "	---	--	---	" "	"	---	125	" "	Jamesburg, N. J.	1901	--	--	--	---	---	1914	10.0

RECORDS OF COMPLETED SERVICE TESTS OF TIES.

Species	Dimensions	Form	Preparation	Preservative	Process	Absorption Lbs. per cu. ft.	No. of ties	Railroad	Location	Track condition						Date 100% removed	Average life Years
										Date set	Tie plates Kind	Tie plates Size	Kind of spikes	Ballast	Traffic		
Pine southern yellow	7"x9"x8'	Hewed	---	Creosote	---	---	200	N.Y. N.H. & H.RR.	Fair Haven, Conn.	1907	---	---	Cut	Stone	---	1918	11.0
"	"	"	---	"	Full Cell	---	500	"	"	1906	---	---	"	"	---	"	12.0
"	"	"	Seasoned	Zinc chloride	Burnett	0.58	6367	A.T. & S.F. Ry.	Newton, Kansas	1904	Yes	7½x9	"	Rock	1603475	1920	13.8
"	"	"	"	"	"	0.40	61	Union Pacific RR.	Norfolk, Nebr.	1908	No.18	6½x8	"	---	---	1919	11.0
"	---	"	---	Zinc creosote	Allardyce	0.6	189	G.H. & S.A. Ry.	Watkins Cut Off	1896	None	---	---	Rock	---	1914	14.0
Pine, southern yellow	---	---	---	Zinc creosote	Allardyce	0.6	1098	G.H. & S.A. Ry.	Watkins Cut Off	1896	None	---	---	Earth	---	1917	15.6
"	---	Hewed	---	"	"	"	410	"	"	"	Yes	---	---	Rock	---	1914	14.0
"	---	"	Seasoned	Zinc tannin	Wellhouse	---	100	Norfolk & Southern RR.	Norfolk, Va.	1897	---	---	---	---	---	1918	16.8
"	---	Sawed	"	"	"	---	"	"	"	"	---	---	---	---	---	"	15.8
Pine, western yellow	Triangular 12"	"	"	Zinc chloride	Burnett	0.5	2916	Great Northern Ry.	Moravia, Idaho	1903	Goldie	6x8½	Cut	Gravel	6052284	1917	13.8
Pine, white	---	---	Seasoned	Zinc tannin	Wellhouse	---	86	D. & I. RR.	Minnesota	1890	---	---	Cut	Gravel	Light	1908	15.0
Sycamore	---	---	---	None	Untreated	---	86	C.B. & Q. RR.	Lines East	1909	Partly	---	"	Cinders gravel clay	---	1918	8.7
Tamarack	6"x8"x8'	---	---	Barschall salts	Hasselmann	---	98	G.C. & S.F. Ry.	Beaumont, Texas	1902	None	---	"	Sand	Heavy	1911	4.0
"	---	Hewed	Seasoned	None	Untreated	---	125	C. & N.W. Ry.	Janesville, Wis.	1907	None	---	"	Gravel	Light	1917	6.4
"	---	"	"	"	"	---	62	"		"	"	---	"	"	"	1916	6.8
Tamarack	---	---	---	None	Untreated	---	86	C.B. & Q. RR.	Lines East	1909	Partly	---	Cut	Cinders gravel clay	---	1915	4.7
"	7"x8"x8'	Sawed & Hewed	---	"	"	---	2168	Great Northern Ry.	Fortine, Mont.	1904	None	---	"	Gravel	---	1914	7.4
"	7"x9"x8'	Sawed	Seasoned	"	"	---	2916	"	Rimrock, Mont.	1905	H.P. 700	6x8½	"	"	2144800	1918	7.6
"	"	Sawed & Hewed	Green	"	"	---	2894	"	Newport, Wash.	"	H.P. 721	"	"	"	6052284	"	6.7
"	6"x7"x8'	Hewed	"	"	"	---	100	C. & N.W. Ry.	Verdi, Minn.	1914	None	---	"	"	---	1920	6.0
Tamarack	6"x7"x8'	Hewed	Green	None	Untreated	---	100	C. & N.W. Ry.	Chadron, Nebr.	1914	Sellers	---	Cut	Gravel	---	1920	6.0
"	6"x8"x8'	---	Seasoned) steamed)	Zinc creosote	---	0.3 zinc*	51	G.C. & S.F. Ry.	Beaumont, Texas	1908	None	---	"	Sand	Heavy	1914	6.0
"	---	---	"	"	Allardyce	0.24 zinc) 3.0 creo.)	50	"	"	"	"	---	"	"	"	1911	9.0
"	---	---	Seasoned	Zinc tannin	Wellhouse	---	86	D. & I. RR.	Minnesota	1890	---	---	"	Gravel	Light	1908	18.0
"	---	---	Seasoned) Steamed)	"	"	0.58	100	G.C. & S.F. Ry.	Beaumont, Texas	1908	None	---	"	Sand	Heavy	1918	10.0
"	---	---	---	"	"	---	200	Penn. RR.	Kosciusko, Ill.	1908	---	---	---	Gravel	---	1908	6.0

*Followed by heavy creosote treatment.

VICE-PRESIDENT ANGIER: Gentlemen, every wood-preserver is interested in test records. We do not know what our timber is doing unless we keep these records. This report ought to bring out some discussion.

MR. WATERMAN: Mr. Chairman, I know the men on this Committee will be delighted to have some real constructive criticism. They don't want anybody to find fault with them, but they would like information as to how they can improve their report.

I notice in this statement single ties, o-n-e experimental tie, given the full-cell creosote treatment and it actually lasted nine years or eight years. That is the most absurd thing I ever saw in print.

There is nothing in this report that indicates what kind of a test section is the better, or maybe they did not want to go that far. But what kind of a test section would they recommend? There is nothing in this to guide a single man in this convention as to what would be the better test section. We ought to emphasize what we are doing, so men can get hold of the actual results we are accomplishing.

This report recommends that no test section be reported on until it is finally complete, or words to that effect. We have test sections that will not be completed in forty years. Art you going to wait forty years before you announce to the people in this country the results you have obtained? I would have had this Committee show the results they are getting out of their test sections which are six or seven miles long. The Santa Fe Railroad has test sections on every superintendent's division. I would have had them show what they have accomplished by these test sections, and they can show it. They can probably show that a few years ago they were replacing 300 ties to the mile, while in the past ten or twelve years that they have been using treated ties, they have reduced that down to 150 and possibly 100. Why don't you bring that out in this report, so that we can know what we are doing?

I hope to get this convention with me on a motion I am going to make before I sit down. The motion is that we eliminate from this statement every report of less than fifty ties. A test of three ties isn't anything. A test of one tie is worse than nothing. So I hope that when we print this statement nothing less than fifty ties will show, because you and I know that it is impossible to draw conclusions on less than that number, and it might better be more.

MR. E. H. BOWSER: I second the motion.

MR. COOPER: Mr. Chairman, so far as Mr. Waterman's criticism of the report is concerned I want to assure him that it is taken all in good part, but I think that Mr. Waterman will agree with me that in practically revolutionizing the method of reporting tests some errors are bound to creep into the first attempt. It never was intended that anything should be reported less than from fifty ties. The clerks reported everything that the records showed.

So far as the completion of tests is concerned, I think there is in existence a table which practically says that when sixty per cent of the ties have been removed you can consider the test closed. I do not think it will be sixty years, even with ties put in now, before you will be able to get some very interesting results. So far as reporting the method of complete test sections is concerned, the Committee had no instructions to do this. They wished they had. If they had been so instructed, they would have been very glad to have undertaken to put before you a scheme whereby you can get accurate data on the life of the ties in test sections.

VICE-PRESIDENT ANGIER: Before putting Mr. Waterman's motion we will allow more discussion on the paper if any one has anything to say.

MR. WATERMAN: Sixty per cent must be removed before you can consider a test section complete, is that right?

MR. COOPER: Sixty per cent.

MR. WATERMAN: Has been removed.

MR. COOPER: When sixty per cent have been removed you can approximate the average life that the ties will give in the track.

MR. WATERMAN: Well, we have a section that has been in twenty years, and sixty per cent have not been removed to date, so if I did not report it you wouldn't know anything about it. Now, I think we have to begin early in the game to let the people know what we are expecting and what we are getting out of our treated ties.

MR. COOPER: Mr. Chairman, Mr. Waterman has not given us any guess as to how long these tests are going to last, and what we wanted to give to the Association was something that they could actually talk about and not guess on any probabilities or anything else. Something that had actually occurred in all parts of the country with all kinds of ties, with all kinds of treatment, so that you could base your judgment on something that had taken place rather than on something that will occur at some future date.

MR. WATERMAN: I am with you.

VICE-PRESIDENT ANGIER: Gentlemen, this is a very interesting subject. Is there any further discussion?

MR. REX: Mr. Waterman's criticism is fine and the work of this committee I consider A No. 1. We all appreciate the value of test sections. We look at test sections in different ways, each of us. Mr. Waterman prefers to put his in out of face. He watches them very closely and when they are removed he knows the reason for it. He gives his instructions to his superintendents and his roadmasters and his foremen and everybody that when those ties are removed that he should be notified so that he can look at them himself. The Santa Fe test tracks, on the other hand, which Mr. Cooper has had the pleasure of carrying out, and those of the Rock Island, under Mr. Ford and Mr. Reiser, have not had special ties inserted in them. They have taken a section as they found it.

For instance when the Santa Fe laid a double track through Kansas in 1906 it laid sixty-six miles of loblolly pine ties out of face on its heaviest freight main line. In 1914 when the rails were worn out and they had to be removed there was not a single tie removed from that sixty-six miles of track. We, therefore, said that we would pick out six miles of this section and keep a permanent record of that six miles, so we took a complete record of that six miles and have kept a record year after year since. In 1920—I haven't seen the reports for 1921—four per cent of those ties in that six miles, loblolly pine ties, had been taken out of that experimental section, and two-thirds of the gentlemen in this room would probably say you could not use that grade of wood.

MR. WATERMAN: How many years?

MR. REX: Since 1906, that is fourteen years, four per cent loblolly pine on the heaviest main line of the Santa Fe Railroad, over which the largest freight train movement goes into Kansas City, and a good many passenger trains too The results from that sort of experimental section, I think Mr. Waterman will thoroughly agree with me, are ideal, and if this committee does not include them in their report they should by all means do so. Experimental tracks don't mean anything to most people. The minute you talk about experimental stuff they say, "Oh, you have nursed it. You haven't given it a fair test." Engineer after engineer will tell you that every time you talk to them. The only things that spell anything in tie renewals are the total number of ties you have in track and the total number of renewals. Nothing else counts. The experimental track is worth all the money that is spent for it, and I honor the gentlemen who have charge of these tracks, and have taken such faithful care of them. I think they are an education, and traveling with these superintendents, trainmasters, and roadmasters, like Mr. Waterman does every year for sixty full days is a good thing. We all know we can't get anything from Waterman from the 5th day of September to the 5th day of November. He is out on these experimental tracks, and he is doing magnificent work in educating his people. I consider those particular two months of educating the superintendents, general superintendents, and roadmasters worth more than all the experimental track.

The reports of a half dozen roads represented in this committee, (all of you who have the records), a complete official set of slides showing renewals, would show to engineers and students and chief engineers, the men interested in the subject, and who are going to be interested in it for the next forty years, the absolute information where you are getting fifteen, twenty or twenty-five years out of your creosoted ties, because you are, and this renewal data would go farther than any possible experimental track information that can be produced.

Last week Mr. Waterman and Mr. Belcher loaned me slides that I used in talking to engineering students, and among them were Mr. Waterman's slides of his experimental tracks, showing white oak ties out in four or five years, out of track by a shovel. Those slides were magnificent, and those engineering could appreciate them. His slide showing the creosoted, the Card, and the untreated tie in track side by side, was fine. They could see that sort of thing; but, after all, the information that does them good, and the information the engineer wants to know and wants to have before him and that convinces him that he should spend the money is the information of how much life are you going to get out of all these ties. The only way you can get that is through your whole renewal. I hope that every man in charge of railway records of tie treatment can see that it is necessary and essential to boost the game, both for the commercial plant and the railroad, but above all and everything else, to conserve the timber supply of this country which we are now cutting four times as fast as we are growing it. If we don't get busy on this patriotic stuff and save our timber, our little old business on the railroads is not going to amount to a great deal. We are going to have to raise our rates higher than they are today, to pay for the shortsighted policy of using untreated ties.

We know what can be done. There is a railroad that will average 18 years on all kinds of ties, one of the heavy western lines, over a period of 25 years, and they have reduced their maintenance from 345 to considerably less than 150. That does not mean there are not all kinds of ties there very much longer than 18 years, because in that period all kinds of ties have been ruined from lack of mechanical protection, all kinds of ties have failed from one cause or another. For instance, a million oil treated ties that failed in 5 or 6 years went in to make up that average. We all know that numberless ties have been treated in the past that were partly decayed. We did not know the game at first. We did not recognize some things when we started. We treated ties without knowing their interior condition. Then when we suspected it we put in adzing and boring machines and cut off the ends of every tie, and we found out what it was. Still there were ties too good to throw away, and so we treated them and put them in this track. Now the average is from 18 to 22 years that the Santa Fe are getting out of their ties, and the only reason I am speaking of the Santa Fe is because they have been willing to give their information, spread it broadcast. In that information all kinds of ties go to make up the average, all the poor ties spoken of are in it, and also a lot of white oak. For instance, I happen to know one year they double-tracked the Illinois and Missouri divisions, and they put in over a million white-oak ties. I do not have any record of how much life those white-oak ties gave, but know that the most of them came out in less than 5 years. I do happen to know of one particular case in which the superintendent at Topeka wanted the best tie under the passenger tracks there in front of the depot, and out of all the ties they had on the system he picked white oaks. He was an old-time superintendent. He had had experience with white oaks and he picked them as being the best. He asked me what I would recommend, and I told him Rueping creosoted longleaf-pine ties. He laughed at me, and put in his white oak. Three years from that day our general superintendent came back and said: "Our white oaks are gone." That was in a wet place where they were washing the trains and furnishing water for the equipment. In three years' time every tie was removed from that track, and the general superintendent asked me what ties I would recommend. Again I told him southern-yellow pine Rueping creosoted ties, and he put them in. In making up that average of 18 or 20 years (whichever it may be, Mr. Cooper or Mr. Belcher can give the information), in making up that record all these failures, all these poor ties, are averaged. So the 18 years does not mean the total life of good ties. Let us get all the information into these reports. We have the data and we can give it to the public. It is due to them. We must conserve our forests to a point where they will replace themselves (applause).

VICE-PRESIDENT ANGIER: Gentlemen, this is a very interesting subject, but we will have to move on a little more rapidly. If anyone has just a word or two further in discussion we will be glad to hear it.

MR. HUNT: Mr. Chairman, I think that the whole assembly is agreed on one or two points. First, that we have not yet found the best preservative for all uses, second, that the improvement which we make is going to be based on the record of what has happened in the past. There is some disagreement, however, as to how those records should be presented.

The material we have at Madison is to a large extent sent to us by railroad men. The accuracy of these records depends on the men who send them in, and the men who have kept the records previously. The value of our records to you will depend to some extent upon the way they are presented. If in the future you want no test reported which has less than fifty ties, let us have that understood. If you want only those records reported on which at least sixty per cent of the ties have been removed, let us have that understood. The data can be analyzed, and presented in various ways. It is too expensive to publish the whole record every year, so the Association or the Committee has to decide each year how they want the data presented, and then we can have it presented that way. In the meantime, a condition like Mr. Rex speaks of or that Mr. Waterman speaks of, should be made public in every possible way, and the men who have those records and are not making them public should be induced to do so.

VICE-PRESIDENT ANGIER: Mr. Waterman has made a motion that we eliminate everything from this report where there are less than fifty ties. The Committee is agreeable to that and so it will not be necessary to vote on the motion. Now gentlemen, is there any further discussion on this subject. If not we will excuse the Committee with the thanks of the Association. [*Applause.*]

The next will be the report of Subcommittee 7—01, Economics.

REPORT OF COMMITTEE NO. 7-01—ECONOMICS

To the Members of the American Wood-Preservers' Association:

The instructions of the Executive Committee to this Committee were as follows: "Define the conditions under which the various non-pressure treatments are justified."

The Committee has found it impossible to give to this subject the study necessary to add to, or further expand the very able work of last year's Committee. Feeling that the subject of non-pressure treatments is of considerable importance to the Association, and its relation to that large portion of the public which is largely dependent upon these methods of preservative treatment, the Committee would recommend that a special committee, one that is particularly fitted for the task, should undertake a thorough going investigation into all phases of non-pressure treatments, and we venture to suggest the formation of such a committee, constituted as herein outlined, and that its appointment extend over a period of years that will allow completion of its work.

It is recommended that such a special committee engage itself with the following subjects and be composed of representatives of the several groups enumerated.

1. That a special committee be assigned to the continuous study and investigation of all phases related to employment of non-pressure processes of preservative treatment of structural wood.

2. That the committee eventually construe the economics involved.

3. That the committee acquire detailed service records of non-pressure treatments.

4. That the membership of the committee consist of seven (inclusive of chairman), and be composed of representatives of the following groups:

(1) U. S. Dept. of Agriculture—Forest Products Laboratory.
(2) Railroads—Superintendent of Timber Preservation.
(3) Commercial Creosoting Plants.
(4) Colleges—Wood Technologist.
(5) Engineers—General Industrial Construction.
(6) Manufacturers of Creosote.
(7) Manufacturers of Salts (sodium fluoride and zinc chloride).

5. That the following be appointed members of the committee, ex-officio:

(1) Chairman of Committee No. 3.
(2) Chairman of Committee No. 4.
(3) Chairman of Committee No. 5.

6. That the chairman of the committee shall be selected from the staff of the section of Wood Preservation of the U. S. Forest Products Laboratory.

This report is offered by the Committee as information.

KURT C. BARTH, *Chairman.*
A. W. ARMSTRONG
R. A. CALVIN
C. C. CRAWFORD
L. B. SHIPLEY
H. W. WOODRUFF, JR.

MR. BARTH: This report is offered by the Committee as information.

VICE-PRESIDENT ANGIER: Gentlemen, you have heard the reading of this report. What is your pleasure?

MR. BRIGGS: I move that this report be accepted as information.

MR. E. H. BOWSER: I second the motion.

VICE-PRESIDENT ANGIER: It has been moved and seconded that this report be accepted as information. Are you ready for the question? All those in favor will say "aye"; contrary, the same sign. It is carried.

The next is the report of Subcommittee 7—3—1 and 7—3—2, Flooring and Paving.

REPORT OF SUBCOMMITTEE 7-3-1 AND 7-3-2—FLOORING AND PAVING

To the Members of the American Wood-Preservers' Association:

The work for the Committee for this year was outlined as follows by the Executive Committee:

1. Develop standard methods of flooring.
2. Develop standard methods of paving, giving special attention to bridge pavements.
3. Continue the study of standard methods of paving street car tracks.

It has been impossible to get the members of the Committee in session together in time to have the tentative specifications, herewith submitted, printed and distributed in advance of this Convention. Consequently, these proposed specifications are submitted for the purpose of providing the basis for a final draft to be submitted at a later date for adoption for the manual.

The Committee finds that the specifications for interior floors and street pavements, which have been adopted or considered in former years, are not in any case, to be found as a whole in any one of the past Proceedings of the Association. The wide use of the "Bituminous Paint Coat" construction in both flooring and paving has received the consideration of former conventions and specifications have been proposed and adopted covering it, but it belongs as a part of the paving specification and not as a specification in itself.

Likewise Interior Wood Block Floors have been defined as "floors laid in heated or constantly dry rooms or roofed enclosures, when the blocks will not be subjected to moisture or to very humid conditions." If we confine ourselves to such a limited sphere in our flooring specification, we cannot truthfully say that we have covered the ground. We should, if possible, develop specifications that will meet flooring conditions in general. Creosoted wood block floors are particularly adapted to successfully encounter moisture, humidity or flushing with water or acid solutions, it being purely a construction problem in the absorption of the expansion of the blocks and the use of a water or acid proof binder between the units.

The question of the treatment of wood blocks has been so thoroughly discussed and has been standardized so well it has not been considered necessary to do any work along those lines. This work has been carried out by the co-operation of the American Society for Municipal Improvements, The American Society of Civil Engineers, and the American Wood-Preservers' Association and no material changes have been made or suggested along the line of oils or treatment. The construction details of the specifications, which the Committee considers to be of paramount importance and vital for the success of any floor or pavement, have been enlarged and elaborated upon and embody the latest and most successful practice which has been brought to our attention.

The Committee has studied the floors and pavements which are now in use from a service standpoint and has endeavored to take advantage of the lessons which they have taught.

The old Nemesis of wood block paving was expansion with subsequent buckling. The wide adoption of the bituminous paint coat construction, which abolished the use of a cushion between the blocks and the concrete base, practically eliminated this trouble.

This can be accounted for principally by the elimination of the recess for the pocketing of water and moisture in the cushion under the blocks and the substitution therefore of a coating of bitumen over the base, which seals the under side of the blocks.

It has been found, however, in a number of cases that the elimination of expansion was accompanied by a new factor which must be considered as extremely vital, namely, shrinkage or contraction of the blocks. This shrinkage of the blocks, in a number of cases, has been almost as detrimental as the expansion formerly encountered. When shrinkage occurs, it is usually accompanied by a slippage of the blocks and the rows of blocks, which are lubricated by the coating of bitumen over the concrete. This tendency for the blocks to slip and travel out of line on the base also has a tendency to force the blocks against the expansion joints along the side curb and eliminate them.

This factor of shrinkage in connection with the bituminous paint coat method of construction has entirely altered the problem of the preparation of the lumber before treatment. Where formerly it was considered necessary to have the blocks manufactured from green lumber or to expand it to its maximum size before treatment, it is now advisable, with the new method of installation, that the lumber be at least partially seasoned and that it not be expanded to the maximum dimensions when the blocks are laid. This factor also cancels the former recommended procedure of wetting the blocks down thoroughly before laying them.

In St. Louis, this factor of shrinkage was considered to be so important that they adopted a method of using jack screws to force the blocks closer together in laying. These pavements so constructed have not been in service long enough as yet to be able to tell whether they will be successful or not. The Committee considers this a radical step which is not justified and one which may meet with disaster except when used in conjunction with careful moisture tests on the condition of the timber being used. This method is certainly not to be recommended except in connection with green timber and in hot climates. The use of air-seasoned timber is far better practice and should eliminate this difficulty.

The climate has a great deal to do with the problems herein discussed. There will be more tendency for shrinkage in summer in the southern cities and it is also important that bitumens of higher melting point be used for fillers in those localities.

We find, upon investigation of the paving practice in London, England, that they have been laying their blocks with a bituminous filler in the joints upon a smooth finished concrete base without any cushion or bituminous coating on the concrete. These pavements have been very successful and they have not experienced the above described troubles with shrinkage of the blocks. This method has also been tried with success in this country and so we have incorporated in the Specification for Street Paving the "Without Cushion" method, which consists of laying the blocks directly on a bare smooth concrete base, filling the joints of the blocks afterwards with a bituminous filler.

In the bituminous paint coat method of construction, there have also been some difficulties encountered with floating of individual blocks here and there by the bituminous filler. This can be corrected by the use of a bitumen of a higher melting point and the range of melting point for coal tar pitch fillers has been raised five degrees in the proposed specifications. Each individual locality, however, should receive special consideration before deciding upon this particular point. Some southern cities could very well raise these limits and in the northern climes, these limits may be too high. Coal tar pitch suitable for use in St. Louis might be entirely too brittle for Minneapolis.

One of the most important features in connection with the construction is the application of the bituminous filler in the joints of the blocks. The bituminous filler serves several vital functions all of which contribute to the long life of the pavement. It stands to reason that as the pavement becomes subjected to wear and tear and the blocks expand and contract for a period of years, this bituminous filler is bound to become dissipated and disappear.

Consequently, it is vitally important that a wood-block pavement receive the attention of a maintenance service consisting of a bituminous treatment from time to time after it has been in service a few years. This treatment should be given in the late summer, while the weather is dry and warm. It should consist of a treatment of heavy bituminous road oils followed by sharp sand or stone screenings, which treatment will cost very little but which will prolong the life of the pavement very materially.

The Committee recommends that the Committee for the coming year give whatever attention is necessary to complete the specifications for interior floors and street specifications started by this year's Committee, and furthermore that they co-operate with the Joint Committee on Highway Bridge Design to prepare a Bridge Specification for Creosoted Wood Bridges, including the treatment of the timbers, and the design of the floor structure, paying particular attention to the factor of fire hazards.

Any further specifications for car track paving should be done in collaboration with the American Electric Railway Engineering Association.

L. T. ERICSON, *Chairman*,
ELLIS R. DUTTON,
SMITH D. HICKS,
K. J. SCHMAELZLE,
L. P. KIMBALL,
THOS. A. LAWTON,

MR. ERICSON: The specifications to be proposed by the Committee after their work this year will be submitted in plenty of time for every member to study them before we adopt them for the manual next year. I have fifty copies each of tentative interior-flooring specifications here on the table, and I hope that everyone who is interested in this subject will come up and get copies. The committee next year will welcome some word of criticism or some word of advice from any one who has anything to submit. The Committee recommends that the Committee for the coming year do whatever is necessary to complete the specifications for interior flooring and street paving, and furthermore that they cooperate with the joint committee on highway bridge design to prepare a bridge specification for creosoted wood including the treatment of the timber and the design of the floor structure, paying particular attention to the factor of fire hazards, and further that the specification for car track paving be prepared in collaboration with the American Electric Railway

Engineering Association. It might be well at this time to advise that there has been a joint committee appointed to investigate wooden highway bridge design, particularly in reference to fire hazards. This Association has one member on this joint committee. The joint committee consists of Mr. George W. Booth, Chief Engineer of the National Board of Fire Underwriters, New York City; Mr. F. E. Kelley, Bureau of Public Roards, Washington, D. C.; Mr. D. F. Holtman, Construction Engineer of the National Lumber Association, Washington; and myself, representing this Association. I think that probably a report will be called for later on as to the work that will be carried on by this Committee, the necessity for the same, and any other information that might be of interest. [*Applause.*]

VICE-PRESIDENT ANGIER: Gentlemen, you have heard this very interesting report. The report, as I understand it, can be accepted only as information for the reason that it was not printed in time. A motion will therefore be in order to accept this as information.

MR. BUEHLER: Mr. Chairman, I was greatly interested in what Mr. Ericson had to say about the maintenance feature of wood block. I have had the oportunity in the last five years to give that question some study and have seen it tried out, and have had an opportunity to study the result where it has been tried out in a number of cities. From the result of our experience we find that the oil necessary to obtain the best results must be one that is fairly light so that it will penetrate the surface of the block. As a rule we find that there are two types of maintenance; that is, two conditions of wood-block surfaces that require maintenance. In one the block itself has dried out, and the joints have closed up fairly well. In such conditions the oil used in the treatment must be fairly light and must be applied hot, and an interval of about twenty-four hours must elapse between the application and the covering of sand to permit it to penetrate into the surface of the block. There is another condition in old block pavements where the joints have opened up. If you will observe an old wood-block pavement you will find, especially where they used sand filler in the old days, that the joints have opened up as much as a half to three-quarters of an inch, and in a case of that kind we find that it is best to use an application of light oil, hot, followed with an application of a somewhat heavier oil. Then, instead of covering with sand, cover with a fairly-coarse chip and roll it in, rolling the chip into the joint, and forming a thin mat on the surface of the pavement. Ordinarily so-called mat coats on pavements have not been successful, and where the joints are not opened up it is best in this maintenance to have a light oil that will not form a mat but where the joints are fairly wide it is necessary to form a slight mat on the surface.

MR. LARKIN: Mr. Chairman, it is discouraging to listen to Mr. Buehler and his reference to maintenance of wood block pavements. It is certainly a shame to think that we are now compelled to adopt real expensive and definite methods to doctor up our wood block pavements to make them last even five years in satisfactory useable condition. In the first place, wood block pavement is very nearly the most expensive pavement that is used. It is considered by the layman, at least, and by a good many experienced engineers to be a permanent pavement, and it seems to me that this Association after all that it has gone through, and considering its ambition to improve the quality of its pavement and creosoted materials would be working along other lines than the one outlined by Mr. Buehler. It really seems quite out of the question to go before property owners and city officials with a pavement that is as expensive as creosoted wood blocks and at the same time have a definite program outlined in this Association for the maintenance of that pavement during the early period of its life. I do not believe such a program of maintenance will ever be necessary if the committee that has charge of the wood block specifications will consider carefully the preservative used and make it suitable for the purpose.

Mr. Buehler says he has been traveling around the last five years examining pavements, and has had a chance to see that maintenance is necessary, and that a light oil should be spread over these pavements that will penetrate the wood blocks. Why? Because something has happened to those blocks. They have dried, and they have in some cases contracted, left voids in and between the blocks. There is no doubt from his own statement that there are voids in the timber itself, because he figures that those voids ought to be filled with an oil, and that a mat coat is not sufficient. I thoroughly agree that there are voids in some of these pavements, the preservative in a period of anywhere from three to five years has evaporated out of these pavements. The pavements that we are most familiar with have been manufactured in most cases from a mixture of tar and oil, the tar being for the most part on the outside portions of the treated block, and the lighter oil the more volatile oil, having penetrated, will later volatilize, and push the heavier inert matter out when the pavement gets heated through and through during summer temperatures. We have watched it happen year after year. We have seen this material scraped off the streets time after time and hauled away. We have watched during the first five years life of the pavement and we have seen that it has been fairly successful, no difficulty outside of the expense and the nuisance of the exuding preservative. What happens next? Almost invariably on a pavement of that kind the blocks get dry. You can't take the preservative out of the blocks without leaving voids, and they have a dry, light-colored appearance. They absorb moisture, and they do buckle up, and give trouble.

Now there are plenty of arguments to the effect that the sand cushion is responsible entirely for that difficulty. It is true that the elimination of the sand cushion from the construction of these pavements does help tremendously. It is a logical improvement, a real improvement in the specification, but nevertheless when you see what happens to the surface of these pavements, and what is necessary to put them in shape again, namely, to fill up the voids that have been left through the loss of the preservative, it looks as though something is wrong with the preservative itself. It looks as though the preservative was too volatile, was of a wrong character, and should have the attention of the committee.

This experience that Mr. Buehler refers to is almost positive proof of what we have seen all over the country; that we are using a material for the treatment of paving blocks that is not permanent; that we should figure on a more permanent preservative, one that when it goes in will absolutely stay in under any and all conditions of weather, temperatures, and so forth. I believe that that is a thought that the committee should keep in mind for future investigation.

MR. BUEHLER: Mr. President, I would like to correct an impression that Mr. Larkin has evidently gotten from my statement. The pavements that have needed maintenance have not been the pavements that have been treated by the standard oils and standard methods of the Wood-Preservers' Association. They have been the pavements that have been, as a rule, treated prior to the adoption of standard methods by this Association, and standard preservative specifications. I do not believe it is necessary for me to remind any of the older members that I am about as enthusiastic an advocate of wood-block pavement as this Association has. I can't help but realize, though, that we are facing a condition and not a theory. The wood-block pavement is rapidly becoming a pavement of history rather than a pavement that is being used at the present time. If you will compare the yardage of wood block laid in the last year or two, leaving out the interior wood block which has been rapidly increasing in use, it will be found that the use of wood block for street paving is decreasing every year. There are probably two good reasons for this. One reason is there has not been a real concerted effort on the part of wood-block manufacturers to put their pavement before the public in the way it should be put before the public. There is probably another reason, and that is, these older pavements are bad advertisements for wood block. If these older pavements are maintained (and they can be maintained at a very low cost), and put into condition so that they will not be an eye-sore to the public it will be far easier to promote again the use of wood-block pavements.

In the early days when we first attempted to sell wood-block pavements we had the old cedar block to combat. Every one thought of the old cedar block. Today they do not point to the cedar block, but they point to these sand filled pavements and the earlier pavements treated with ten or twelve pounds per cubic foot, laid with sand filler and sand cushions.

As I say, we are facing a condition and not a theory, and I firmly believe that we can again put wood block on the map, especially in the South. In towns through Texas, Florida, and that southern fringe of states, with the possible exception of New Orleans, it is very difficult to interest any one in wood-block pavement. If any one would go to Texas today and attempt to promote wood-block pavements in any of the cities they would probably be run out of town, due to the condition of the wood-block pavements there. There is no use fooling ourselves on that. We can lay wood-block pavements under our present specifications, the modern way of laying it, that will not result in the trouble they have had in Texas, but we first must put the wood-block pavement in Texas in a condition so that people will again want that pavement, and it can be done at a very low maintenance cost.

MR. MANLEY: Mr. Chairman, I want to add a word in support of Mr. Buehler's position. The condition exists because, like everything else, wood block was a gradual growth. Those who were engaged in the industry learned only by experience and mistakes, and it would be far better that the eye-sores which exist throughout the country should be converted into smooth pavements by the use of top dressing, than that they should continue to exist as detriments to the industry. That condition is not confined to any one part of the country. It is possibly worse in Texas than any other place. The conditions are particularly bad in Texas. The extremes of heat and the extremes of rainfall render the conditions extremely bad for sand-cushioned and sand-filled pavements. New Orleans, mentioned by Mr. Buehler, happens to have a different climate. There is always moisture enough there so that this terrible drying out of blocks does not result. One of the worst cases in the South is Mobile. Mobile has more wood blocks per capita than any other place in the United States. None of it has been laid in the last few years, but there is none of the wood block in Mobile but what could be converted into usable roadways, and the question of the preservation of wood is not to be considered at all, because with an occasional exception where the wood may possibly have had some decay, the blocks are sound, but they are wonderful to look at after the rain! [*Laughter.*]

VICE-PRESIDENT ANGIER: Gentlemen, our time is getting short, and we will have to limit the discussion.

MR. LARKIN: Mr. President, this is an important part of the deliberations of this Association, and I think the necessary time should be allowed for the discussion of it. The only reason that I got into this discussion this morning and the only reason that I think that time ought to be given to it is for exactly the reason that Mr. Buehler has outlined, and that is that we are not getting any wood block business in this country to speak of or as compared to the work that we have had in the past years. It is getting less every year. Now why? Is that a healthy condition, and should it be discussed in this meeting or not? It looks to me as though it is very proper to give whatever time is necessary to the discussion of the situation, if there is any capacity in this Association to remedy the difficulties—I don't know whether there is or not. We all know that we are getting less and less of this business, and that wood blocks, as a general proposition, have a "black eye," in this country. It is getting harder to sell them all the time. We have had a lot of fine business in wood block pavement. It is a large proportion of the business that the members of this Association do. Mr. Manley's remarks only further verify the points that I made first, when he says the blocks dry out down in the South. They do dry out. I agree with him that the sore spots should be fixed, but what are you going to do with pavements that have been laid under the specifications now in force and in the last five or ten years, where they have blown up and given trouble just as I outlined before, and in some cases where the sand cushion has not been disturbed? That has happened in Minneapolis and St. Paul in three to five year pavements. It is getting to the point where under the present specification a manufacturer feels that he is just building up a bunch of trouble for himself in the future by manufacturing under such a specification, and it seems to me that the thing to do is at least to consider the possibility of eliminating entirely any drying out of these blocks.

Mr. Buehler has referred to the increase in the use of wood blocks for interior purposes. I do not know that he will agree with me in this, but I believe that for the most part those blocks are being treated with pure oil and with less volatile oil than has been used for street paving. Some of our architects and engineers have given this matter careful study and they are getting to the point where they are trying to eliminate in their interior floors the difficulties that have been experienced on street pavements.

Now, just take under consideration for a minute the possibilities at least of using a preservative that is absolutely not volatile, that is pure oil, that will not volatilize in ordinary temperatures temperatures that a pavement is subjected to, and does it seem reasonable that if you fill up pavements with that kind of an oil that you get a pavement that will dry out? You can subject a pavement treated with that kind of an oil to the most rigid and severe tests and you will not get any change in the oil or the blocks, no further expansion, no contraction. It seems to me it is a point very worthy of consideration by the committee.

MR. ERICSON: The committee has studied this matter from the service standpoint and they have agreed that the methods of treatment recommended have not been at fault. The methods of treatment which were incorporated in the specifications two or three years ago are not at fault. The matter of the oil was considered very carefully by a joint committee of national societies, and we can't find that the fault in the pavements that are being laid today is with the oil when that oil has been used. We find very little if any trouble with bleeding, which Mr. Larkin has described when this treatment and these oils are used. We do believe, however, that there is large room for improvements in the fillers which may be used in these pavements. We would like improvement in these fillers, and I think it can be accomplished. It has been well observed that no matter what treatment is used, or what oil is used, these blocks will expand and contract and they are never constant in volume.

The recommendation in regard to maintenance was made general but perhaps there should have been a provision that this maintenance service should be given only when it is necessary. In a great many cases there has never been any attention given to the maintenance. Pavements have been destroyed which I think, with a little attention, would have given five or six years more service, and if a small maintenance charge will prolong the life of a pavement five or six years or any appreciable length of time, certainly it is worth while giving this treatment to the pavement. We believe that with the improvements in the specification which have been suggested these failures will be eliminated. We practically eliminated expansion and buckling when we adopted the pitch paint coat construction. We encountered this unexpected difficulty of shrinkage in some cases, but we think that by following the recommendations of the specification proposed this year we can eliminate both the shrinkage and the buckling. Of course we may still be wrong. We have made mistakes before, and we are all human, but I do not think that this committee is the committee to handle the matter of oils or preservatives. I think that is in the province of the Preservatives Committee. The present Committee, I believe, is all agreed on accepting the specifications for the preservatives which were adopted by these joint associations.

MR. LARKIN: Mr. President, the Chairman of the Committee may not be able to find in the scope of their investigations the difficulties that must be eliminated to make the pavements a success. They are coasting along on the preservatives that have been handed to them by the Preservatives Committee. There is no chance of getting any consideration of the Preservative matter until this committee can in its deliberations and in its investigations find that it would be logical for them to suggest that perhaps they cannot eliminate all of these troubles by adjustments of cushions and methods of laying. I know that that is the scope of the committee, but it is quite possible that when they get to examining blocks, and find that the blocks themselves do contract or do expand, and that they do dry out, as Mr. Manley says, and that they do buckle and give trouble, that perhaps it would be logical for them to consider going back to the Preservatives Committee and possibly recommending that perhaps a test pavement or some question be raised with reference to the specifications. Mr. Erickson says that we are all human and that there is a possibility of mistake having been made. It is true that if we are going to progress as we should we must improve the materials entering into the construction of the creosoted materials. We can't take a specification adopted five or six years ago, and say that that is the specification and that we cannot make any further improvement in it.

VICE-PRESIDENT ANGIER: Is there any further discussion on this report?

MR. CARD: Mr. Chairman, I would like to say a word. I think the Committee is on the right track. There is a test pavement here in Chicago that has been down now for eight or nine years that was laid on smooth concrete with a paint coat for a cushion that is absolutely as good today as it was the day it was put down. Every street in this town that we have had any trouble with, especially street-car streets, is due to the sand cushion under the blocks. I have yet to see a decayed block come out of any street that has been repaired or torn up. You won't find them if you travel from one end of town to the other, but you will find where grout was supposed to go in under these blocks as a cushion, nothing but sand, and the continual vibration has worked it out, and the water has gotten under and moved the blocks. There is your whole trouble, I think.

VICE-PRESIDENT ANGIER: If there are no further remarks a motion will be in order to accept this report as information.

MR. MANLEY: I move it be accepted as information.

MR. STEINMAYER: I second the motion.

VICE-PRESIDENT ANGIER: It is moved and seconded that this reported be accepted as information. Are you ready for the question? All in favor will signify it by saying "aye;" contrary, the same sign. The motion is carried, and the Committee is excused.

The next on the program is a paper by Mr. Hendircks on "The Economics of Cross-Tie Renewals."

MR. HENDRICKS: Mr. Chairman, in order to save the time of the convention I suggest that we dispense with the reading of this report, as the Association will gain nothing by such presentation, and that we pass directly to the discussion. I think that will be more interesting, anyway.

THE ECONOMICS OF CROSS TIE RENEWALS.

V. K. Hendricks.

In view of the numerous publications which have appeared on this subject heretofore, it may seem that an apology should be offered in connection with any further discussion. However, there is considerable misunderstanding of the subject and a lack of uniformity in the methods of figuring economies. This discussion is presented in the hope that it may aid in bringing about a clear understanding of the question and in securing uniformity in the methods used. No claim is made to originality in this paper, and it is merely presented as a supplement to what has been published previously.

In general there are three methods advocated for calculating cross tie economies, which are, in the order of their simplicity:

a. Without consideration of interest.

b. By the use of simple interest.

c. By the use of compound interest.

In order to adopt the simplest method consistent with reasonably accurate results, we should determine the difference in results by these three methods, which methods are represented respectively by the following formulas:

$$a.\quad A = \frac{C}{n}$$

$$b.\quad A = \frac{C}{n} + CR$$

$$c. \quad A = C \frac{(1+R)^n R}{(1+R)^n - 1}$$

In each formula: A=Annual cost per tie.
C=First cost of tie in place.
R=Interest rate.
N=Life of tie in years.

In the paper on "A Method for Finding the Annual Charge for Ties," presented before this Association in January, 1915, by Messrs. Harrington Emerson and T. T. Bower, an allowance is made for a tax rate (assumed at 1 per cent per annum) on the value of the tie, but there is no uniformity as to the method of taxation in the different states, and it is probable the kind of tie used would frequently, if not generally, have no effect on the taxes assessed. For this reason the tax rate has been eliminated from their formula as given above under *b*, and it is not included in either of the other two formulas. Formula *c* is the formula adopted by the American Railway Engineering Association (see 1915 Manual, p. 64) in which the annual charge equals the sum of (1) simple interest on the cost of original installation and (2) the amount, which, at annual compound interest, will provide for renewal at the end of the life of the tie, without allowance for any scrap value of the old ties. In the case of steel ties a scrap value should be provided for, but there is generally no salvage recovered from wood ties.

This formula provides for the annual charge to be made at the end of each year. In order to provide for the payments to be made at the beginning of each year, the formula would be:

$$A = C \frac{(1+R)^n R}{[(1+R)^n - 1](1+R)}$$

This is merely dividing the result by the A. R. E. A. method by one plus the interest rate, and since either formula gives correct relative results and the A. R. E. A. formula is simpler, its use is recommended.

There can be no question but that the method *c* of calculating the relative economy of various ties, using compound interest, is the correct method, but the other methods have their advocates, and the claim is sometimes made that a simpler method will give reasonably reliable results.

This compound interest formula (method *c*) was published by Mr. B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, in Forestry Division Bulletin Nov. 4, 1890, and the following quotation from that bulletin (p. 34) is of interest:

> "We may dismiss at once as improper in a community with well established financial systems, any calculation which does not apply compound interest. There can be a dispute only as to the rate of interest, which in discounting long-standing investments is usually taken at less than the current rate of interest. But, while the choice of the rate is of importance, when the actual amount of saving is to be calculated, if the existence only of a saving—no matter of what amount—is to be established, this choice of rate of interest becomes irrelevant, as long as we use the same rate in all cases which we compare. And, especially in the case of two tie systems, the saving which the one of longer duration brings, by virtue of greater safety and permanence of roadbed, is incalculable, so that to establish its superiority financially we need to prove only that it is not more expensive."

Based on the three methods given above, the following tabulation shows results for certain ties having a life of 6, 12, and 18 years, and at certain assumed total costs in track:

Case No.	Total cost in track	Average life of ties	Annual Cost per Tie		
			No interest	Simple interest	Compound interest
		years	cents *a*	cents *b* 6%	cents *c* 6%
1	$1.20	6	20.0	27.2	24.404
2	2.40	12	20.0	34.4	28.7
3	3.60	18	20.0	41.6	33.3
4	1.90	12	15.8	27.2	22.7
5	2.36	18	13.1	27.2	21.8
6	2.046	12	17.05	29.34	24.404
7	2.64¼	18	14.67	30.52	24.404

These costs in track have been established so that cases 1, 2, and 3 show the same annual cost without considering interest (method *a*); cases 1, 4, and 5 show the same annual cost using simple interest (method *b*); and cases 1, 6, and 7 show the same annual cost using compound interest (method *c*).

It will be noted, not only that the annual cost varies materially by the three methods, but also that in cases 1, 6, and 7, where there is no difference in economy according to the compound interest method *c*, method *a* (no interest) shows the higher-cost ties progressively more economical, while method *b* (simple interest) shows them progressively less economical. Such a result would be wholly misleading, and it is therefore evident that an incorrect method cannot be substituted for a correct one in the interest of simplicity, without risk of failure in some cases, to adopt the tie which is really most economical.

Seeing a problem clearly in all its details is a very great aid in its solution, and it may help towards a clear understanding if we follow out the results of these seven cases in actual practice, based on the assumption that each individual tie lasts exactly the average life assumed in each case.

Suppose a road has a total of 1,800,000 ties in track, each one of which lasts just six years, and that exactly one sixth of them or 300,000 ties, require renewal every year. The annual expenditures would then be as follows.

YR.	CASE 1 Ties cost $1.20 last 6 years	CASE 2 Ties cost $2.40 last 12 years	CASE 3 Ties cost $3.60 last 18 years	CASE 4 Ties cost $1.90 last 12 years	CASE 5 Ties cost $2.36 last 18 years	CASE 6 Ties cost $2.044 last 12 years	CASE 7 Ties cost $2.64 last 18 years
1	$360,000	$720,000	$1,080,000	$570,000	$708,000	$613,800	$792,750
2	360,000	720,000	1,080,000	570,000	708,000	613,800	792,750
3	360,000	720,000	1,080,000	570,000	708,000	613,800	792,750
4	360,000	720,000	1,080,000	570,000	708,000	613,800	792,750
5	360,000	720,000	1,080,000	570,000	708,000	613,800	792,750
6	360,000	720,000	1,080,000	570,000	708,000	613,800	792,750
7	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
8	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
9	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
10	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
11	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
12	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
13	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
14	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
15	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
16	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
17	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
18	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
19	360,000	--- ---	1,080,000	--- ---	708,000	--- ---	792,750
20	360,000	--- ---	1,080,000	--- ---	708,000	--- ---	792,750
21	360,000	--- ---	1,080,000	--- ---	708,000	--- ---	792,750
22	360,000	--- ---	1,080,000	--- ---	708,000	--- ---	792,750
23	360,000	--- ---	1,080,000	--- ---	708,000	--- ---	792,750
24	360,000	--- ---	1,080,000	--- ---	708,000	--- ---	792,750
25	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
26	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
27	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
28	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
29	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
30	360,000	720,000	- --- ---	570,000	--- ---	613,800	--- ---
31	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
32	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
33	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
34	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
35	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---
36	360,000	--- ---	- --- ---	--- ---	--- ---	--- ---	--- ---

This tabulation covers a period of 36 years, as that is the least number of years that will complete a full cycle, and bring all seven cases back to the point where there will again be just 300,000 ties per year to be renewed for six consecutive years, as was the case at the beginning of the cycle.

If we figure the "present worth" in each case, that is, the amount of money which, set aside at the beginning of the period and placed at annual compound interest (figured at 6 per cent in this discussion), would furnish, at the beginning of each year, the amount required to take care of the renewals for that year as shown in the preceding tabulation for the entire 36 year period, and compare these amounts with the uniform equivalent annual charges derived by multiplying the annual charges per tie (as previously tabulated) by the total number of ties in track (1,800,000), the results are as follows:

Case No.	Annual Charge for the 1,800,000 Ties in Track by			Present worth of actual cost of renewals for a 36 year period
	Method *a*	Method *b*	Method *c*	
1	$360,000	$489,600	$439,272	$5,579,280
2	360,000	619,200	516,600	6,544,604
3	360,000	748,800	599,400	7,600,785
1	360,000	489,600	439,272	5,579,280
4	284,400	489,600	408,600	5,181,145
5	235,800	489,600	392,400	4,982,736
1	360,000	489,600	439,272	5,579,280
6	306,900	528,120	439,272	5,579,274
7	264,060	549,360	439,272	5,579,187

It will be noted that the relative economy as determined by the annual charge method *c* agrees in each case with the relative economy shown by the "present worth" column. This comparison is not given as a proof that the compound interest method is correct, for, as a matter of fact one method of deriving the formula for the compound interest method *c* for figuring annual charges, is by placing the present worth of the tie renewal charges equal to the present worth of the annual charges, and solving for the annual charge. It is a self-evident fact, however, that:

(1) Cases 1, 2, and 3 cannot have the same relative economy as is shown by method *a*, when it is possible to finance case 1 for a 36-year period for $5,579,280, while it requires $7,600,785 to finance case 3 for the same length of time;

(2) Cases 1, 4 and 5 cannot have the same relative economy as is shown by method *b*. when case 5 can be financed for $4,982,736, as compared with $5,579,280 for case 1; and

(3) Cases 1, 6, and 7, respectively, cannot be progressively more economical as shown by method *a*, or progressively less economical as shown by method *b*, but all three cases must be of

the same economy, as shown by method *c*, since it requires the same total expenditure to finance each case for a 36-year period.

There can be no question as to the possibility of compounding interest, and unless every dollar is in effect worked at compound interest it is not doing its full duty; likewise, any formula for annual charges which does not apply compound interest is wrong financially, no matter whether it is in connection with maintenance or with construction. This may be better illustrated by the following:

Suppose a man is considering the relative economy (from a financial standpoint only, of two suits (which is purely a maintenance problem), one of which costs $30.00 and will last one year, and the other costing $90.00 and lasting three years. In both cases, if no allowance is made for interest, the cost would amount to $30.00 per year, and one would be as economical as the other. By the simple interest method the cost would be (using 6 per cent interest) $31.80 per year for the cheaper and $35.40 for the more expensive suit. By the compound interest method the annual charges would be $31.80 and $33.67, respectively, or an average annual saving of $1.87 by the purchase of the $30.00 suit, making a total saving of $5.62 in three years, exclusive of interest, or $5.96 including compound interest, the saving being available at the end of each year.

In order to see how the two propositions compare in practice, let us set aside $90.00 to finance the clothing for three years, but purchase three $30.00 suits during the period. If we ignore interest on the purchase price of each suit, and apply interest only on the excess cash remaining after each purchase, the transactions will be as follows:

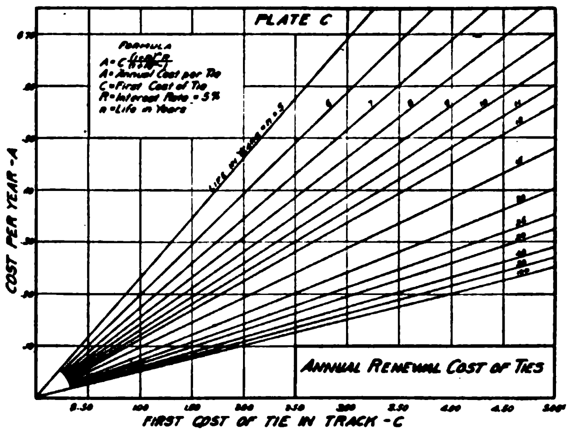
Cash available now	$90.00
Cost of 1st suit	30.00
Amount to be invested for one year	$60.00
Interest one year at 6%	3.60
Cash available at end of first year	$63.60
Cost of 2nd suit	30.00
Amount to be invested for 2nd year	$33.60
Interest one year at 6%	2.02
Cash available at end of second year	$35.62
Cost of 3rd suit	30.00
Amount to be invested for 3rd year	$5.62
Interest one year at 6%	.34
Cash on hand at end of 3 years	$5.96

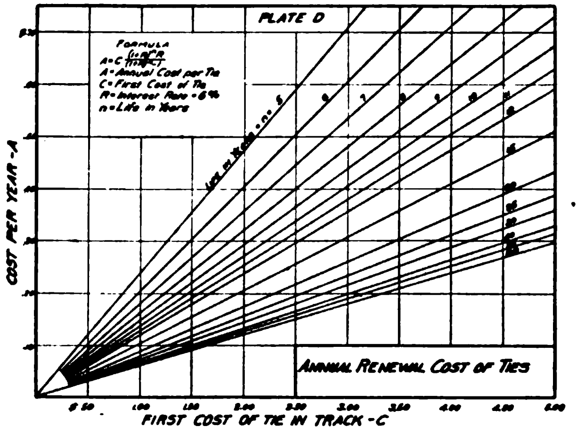
This result checks with the saving as determined by the compound interest formula for annual charges, with the annual savings compounded.

It is unfortunately true that the present accounting rules of the Interstate Commerce Commission do not permit the capitalization of the excess cost of treated ties over untreated ties, and this fact has no doubt had its effect in preventing the use of treated ties to as great an extent as they would be used if the excess cost could be capitalized, as it should be, and as the Commission requires in the case of increased weight of rails and other items. A road will naturally hesitate about swelling its maintenance charges for some six or eight or more years before the benefit of the excess expenditure will start to accrue—and more especially so, if there is a possibility that the road may receive no benefit whatever when the economy does accrue through the limit established by the Transportation Act of 1920 to the amount which the road can disburse in dividends. This question of capitalizing the excess cost of treated ties is a question of real importance to the American Wood Preservers' Association, and one which this Association might well take up with the Interstate Commerce Commission in order that this industry may be given fair treatment hereafter. However, this is a question of method of accounting, and, while the method of accounting might make it expedient for a railroad to continue the use of a less economical tie in some cases, it would not affect the actual relative economy of the ties; the Government would reap the benefit of the installation of the more economical ties instead of the railroad in such cases.

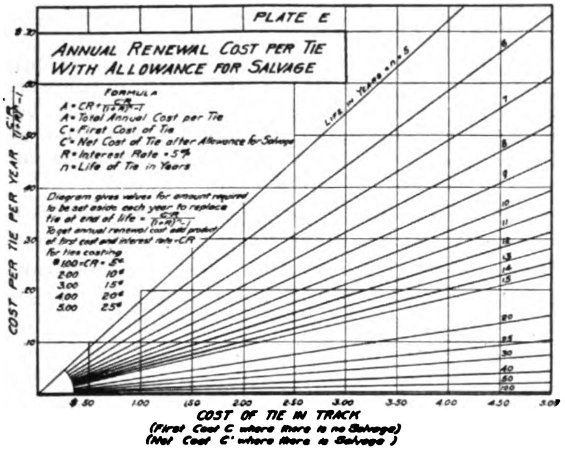
Neither this accounting method, nor the fact that "interest charges are not properly considered an element of maintenance costs in actual present day accounting," can warrant the no-interest method *a* of figuring economies, nor do the reasons given in the paper presented to this Association in 1915 by Messrs. Emerson and Bower, justify the simple interest method *b* instead of compound interest. This latter paper states that the irregularities in the life of ties vitiates any compound interest plan. To a certain extent this is true, but when we compare one kind of tie with another to find their relative economy, both kinds of ties will be subject to approximately the same irregularities, if of wood, and any actual error due to this cause will be practically eliminated relatively. The excess cost of a more economical tie over another tie must be figured at compound interest or else the money is not being made full use of, and if the excess cost is compounded, it will give the same result as though the total cost of both ties had been figured at compound interest originally.

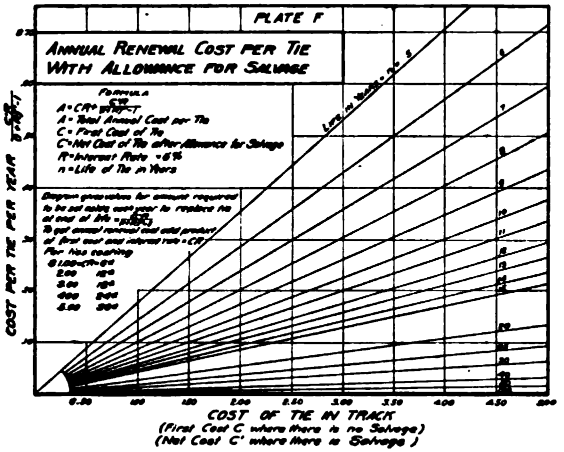
In this discussion the costs of ties, life of ties, and interest rates have been assumed arbitrarily merely for the purpose of





Plates C and D show the annual renewal cost of ties (annual charges) without allowance for any salvage, at interest rates of 5 per cent and 6 per cent, respectively (compounded annually).





Plates E and F., at 5 per cent and 6 per cent respectively, show annual costs allowing for scrap value of the tie.

By the use of these diagrams the true relative economy can be determined at once.

illustration. In adopting a compound interest rate the following quotation from Mr. B. E. Fernow (who calculated his table of annual charges on a 5 per cent basis) in Forestry Division Bulletin 4, should be borne in mind:

> "If a lower rate of interest is used in calculating the annual charges these, to be sure, fall out lower, but the amounts of saving increase. So that it may be assumed that the table calculated upon a five per cent basis gives the most conservative, practically applicable results."

In January, 1920, the Committee on Ties, American Railway Engineering Association, made a report on "The Relative Merits of Metal versus Wooden Ties," to the American Railroad Association. Through the courtesy of the American Railway Engineering Association, plates C, D, E, and F from that report, are reproduced herewith for the benefit of this Association.

The annual renewal costs determined by this method are of value only for determining the *relative* economy of various ties, which, of course, is the only question this Association is interested in primarily. A railroad management, however, would require some estimate forecasting its actual annual renewal expenses, in order to determine the feasibility of increasing its tie charges and to make suitable provision for financing the change. A tabulation showing annual expenditures each year, such as is given in this discussion is probably best and would give an approximate idea of the trend of future expenses, but the irregularity in the life of ties makes it very unreliable for long periods. A closer approximation could be worked out by making use of the data given in the paper by Mabel E. Thorne, published in the 1918 Proceedings of this Association, showing the "Relation between Average Life of Ties and Percentage of Renewals." However, this would require a considerable amount of calculation which would hardly be justified by the results obtained for this purpose.

In determining the relative economy of various kinds of ties, all items entering into the costs of the ties in track should be included in the "First cost of tie in place," as follows:

1. Purchase price of ties, f. o. b. cars.
2. Inspection (of ties and treatment) and handling charges, including distribution of ties.
3. Work train charges or estimated cost of transporting over Company lines (both to and from the treating plant in the case of treated ties).
4. Freight charges over foreign lines, and switching charges.

5. Interest on the cost of ties during the period they are held for seasoning, provided this is not included in the purchase price.
6. Interest on investment in any real estate, plant, tracks, or other facilities required for procuring, seasoning, or treating the ties, when not included in the purchase price, and also maintenance of such property.
7. Cost of adzing and boring before treatment, and any similar expenses not included in the cost of treatment.
8. Cost of treatment.
9. Cost of the plates. We have no authentic information as to the life of tie plates, but if we assume the life the same as the life of a treated tie, then for a tie having only half that life we should include only half the cost of tie plates, and for other lives in proportion.
10. Cost of spikes. In comparing wooden ties with wooden ties, however, the cost of spikes will be the same and that cost could be omitted without material error; in comparing wooden with metal ties, the spikes must be included to correspond with the metal tie fastenings.
11. Cost of placing ties in track.

The item of "Supervision" has been omitted from this list intentionally, as, aside from the direct charges for inspection (which are included), the supervision is a small item and will be practically the same for all ties in most cases. Only such interest has been included in this list as might be considered as really a part of the cost of the tie, as all subsequent interest is taken care of in the formula for annual charges.

There may be special cases where other items should be included in the original cost in track, or where some modification of the preceding list will be necessary, but this list is believed to meet the requirements in almost all cases.

There would be a scrap value for tie plates in all cases where they are used, but that value would not materialize for a number of years, and at that time the prices for scrap might be materially different from current prices. It would be on the side of conservatism to disregard such scrap value, and not use the tie plates unless their use is justified without it. It would, however, hardly be proper to disregard such a large item as the scrap value on steel ties, but a conservative price for scrap should be used for such ties in order to make sure that the full estimated saving will materialize by their use.

VICE-PRESIDENT ANGIER: Do any of you gentlemen wish to discuss Mr. Hendrick's paper? Mr. Harrington Emerson has sent in a written discussion of this paper which the Secretary will read.

The Secretary then read the discussion as follows:

Discussion by Mr. Harrington Emerson

Mr. Hendricks deserves our thanks for his painstaking and exhaustive discussion of this subject.

The back bone of his belief is that compound interest should be used. If this is incorrect, his conclusions are also incorrect. I shall, therefore, limit myself to upsetting what I consider a dangerous fallacy.

Mr. Hendricks states:

"There can be no question but that the method of calculating the relative economy of various ties, using compound interest, is the correct method."

He also quotes with approval a compound interest opinion published by Mr. B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, published in 1890:

> "We may dismiss at once as improper in a community with well established financial systems, any calculation which does not apply compound interest. There can be a dispute only as to the rate of interest, which in discounting long-standing investments is usually taken at less than the current rate of interest."

My own belief as to all human matters is that the constitutional peculiarity of the human animal in all ages and climes is perversity, the instinct to choose the wrong where the right would have been simpler, and that it is only after long suffering from mistakes, after many trials that the truth is finally adopted. This has been peculiarly true in the evolution of railroading in which we are still irrevocably suffering from false premises.

When, therefore, as to any subject whatever the preamble is "There can be no question . . ." I immediately begin to question and when in support of the "no question attitude," unsupported assertions 30 years old are noted, I at once assume that the assertion is probably wrong and that the antiquated opinion must be searchingly questioned, all the probabilities being in favor of it also being wrong.

Let us, for the time being, forget assertions and mathematical formulae and come down to practical facts and this is what I was forced to do a few years ago, when commissioned to outline a contract between a railroad and a tie contractor.

A certain railroad, forty years old, had a floating debt falling due which it could not pay out of income and which was too small to fund.

A tie contractor offered to purchase for cash all the ties in the track, 12,000,000 at one dollar each and to supply, at market prices, new ties of various sizes and qualities.

Tie supplies and tie maintenances were thus to be separated from all other railroad problems.

It was well understood by both parties that although the ties had originally cost about $1.00 each, in the track, they were at the date of contract half worn out, but on the other hand they were operatingly good and worth while, as a going part of the equipment of the railroad.

The terms of the contract were:

(1) That if the contract were terminated or the road discontinued, the contractor's investment in the ties should be repaid to him, in cash, or in case any ties were removed from the track, he was to be paid in case the purchase price for each tie removed, thus lessening the Railroad debt to that extent.

(2) That for the use of his ties he was to receive a flat and variable rental per tie, which we shall assume to be 10 per cent on the going value of tie in track. This made the annual rental cost per tie $0.10 on the basis of dollar ties and this was acceptable to both the railroad and to contractor on the ground that his expenses would be:

Current rate of interest	7.0 per cent
Taxes on value of ties	1.5 per cent
Supervising expenses of all kinds	1.5 per cent
Total	10.0 per cent

The total rental for 12,000,000 ties would therefore, be $1,200,000, payable $100,000 monthly and charged monthly to Maintenance of Ways and Structures.

(3) That he should furnish the replacement tie at current cost, the amount to be added to the debt of the railroad to him.

We can look forward to the average value of the ties as variable (steadily increasing) and we can count on the rental rate as variable, and we can expect the ties to have a chronically shorter life, owing to poorer quality, heavier loads, etc., etc.

Each one of these contingencies is taken care of by the cited provisions of the contract.

The average cost of the going ties is being constantly corrected by renewals, the rate of rental is being constantly readjusted to the current rate of interest and taxes and the actual average life of ties is determined by the renewals.

What is the cost to the railroad of its tie maintenance?

(1) The rental rate per average tie, assumed in this particular case at $0.10.
(2) The renewal cost, assumed for simplicity at $1.00.
(3) The number of renewals.

Renewal Costs for Various Assumptions of Life

Number of Ties Involved, 12,000,000.

Renewals	Average Life	Total Cost of Renewals	Average Annual Cost of Renewals Per Tie	Rental Rate Per Tie	Total Annual Cost Per Tie
12,000,000	1 year	$12,000,000	$1.00	$0.10	$1.10
2,400,000	5 years	2,400,000	0.20	0.10	0.30
1,200,000	10 years	1,200,000	0.10	0.10	0.20
800,000	15 years	800,000	0.067	0.10	0.167
600,000	20 years	600,000	0.05	0.10	0.15

There is no interest either compound or simple in the statement. The current rate of interest, as well as taxes and supervising costs make up the variable rental charge.

So much for the practical facts. The tie contractor receives from month to month what is his due, the railroad charges to operation, monthly the actual costs.

There has never been a case as far as I know where any railroad has set aside year by year a depreciation charge and invested it at compound interest to take care of an ultimate death whose term no one could foretell. Neither steel files in the machine shop, nor ties, nor machines, nor rails, nor freight cars, nor locomotives, nor coaches, nor grades, nor tunnels, nor bridges, nor buildings, nor terminals last any predeterminable or foreseeable term of years.

Neither do interest rates remain constant. For the same railroad they have varied between 3 per cent per annum and 7 per cent.

Prices of replacement have also risen in a comparatively short time as much as 100 per cent. Locomotives used to cost $0.09 a pound and rose to more than $0.20. I have seen ties rise in price from $0.18 to $1.00.

No sound business, whatever, can be done on the basis of the assumptions of fixed life, fixed price and constant interest rate.

The method advocated by Mr. Hendricks is both practically and theoretically unsound. The tie owners and contractors would not stand for it except with an exorbitant insurance risk, the railroads would never know what their costs were.

The real costs are

The actual rental charge in the current month.

The actual paid for destroyed ties in the current month.

If anyone wants to guess ten years ahead as to either rental values or removal volume, he is at liberty to indulge in the harmless pastime, but the chances are all against his guess being near the truth.

I wish I could have been assisted in this discussion by Mr. T. T. Bower, a brilliant Annapolis graduate, who gave his life for his country during the great war.

Vice-President Angier: Gentlemen, you will remember Messrs. Emerson and Bower prepared a paper on this subject in 1915. It is a very important subject, and it is one that we should discuss here a little while this morning because some of us are using compound interest, some are using simple interest and some no interest at all. How are we going to show what the ties cost in track? I think we should come to some conclusion as to how this should be handled. Have you any remarks to make on the paper?

Mr. Hendricks: While I appreciate the great value of Mr. Emerson's views, I cannot agree with him in his conclusions in this case. The governing point, I believe, is the "present worth" of the kinds of ties under investigation (which must be based on compound interest) and which involves the average life of ties. It seems to me the deciding feature as to compound interest is this:—If simple interest on the excess cost of one kind over another were actually paid to you each year, so that you could have the use of the money for reinvestment, then simple interest would be proper. Since this interest is not so paid, however, it is necessary that the interest on interest must be secured from the original investment, which means the use of compound interest.

It was for this reason that I said "there can be no question, etc.," for I realize, as indicated by Mr. Emerson, the mere fact that a method has been used before, is, in itself, no proof whatever that it is sound.

As to the particular case mentioned by Mr. Emerson, the contractor received the interest on his investment in cash, and in the end his investment was repaid, so that he was protected and could reinvest the interest as he saw fit,—in fact the payment of $100,000 each month to cover, amongst the other items, the 7 per cent interest which would ordinarily not fall due till the end of the year, would permit what I may call a "premature" reinvestment, so that he could do better than compounding annually.

The adjustments for the contingencies covered by the cited provisions of the contract, do not change this situation for, when one of the $1.00 ties in track at the beginning of the contract is removed, the contractor is paid the $1.00 in cash, thus reducing the railroad debt to that extent, and the cost of the replacement tie is borne by the contractor but is added to the railroad debt. The contractor always gets his interest in cash on the amount he actually has invested at the time.

In this case the contractor is financing the tie renewals (the railroad merely paying the bills) and since he is, in effect, compounding his interest, the financing is being done in full harmony with the compound interest formula, notwithstanding Mr. Emerson's deductions.

The "annual charge" is of value only, in my opinion, for determining what kind of a tie to use, and when that is decided the railroad would be able to estimate its expenditures for the coming year, just the same as at present, and it would have an actual record of the past year's expenditures, as at present. Before a road would decide to install ties having an expected life of 15 or 20 years, it should by all means, give some consideration as to what may develop in the tie situation during such period, and use its best judgment as to the basis on which its decisions should be founded. This should include consideration of variations in interest rates. In other words, while I believe the relative economy of ties should be determined by a compound interest method, good judgment must be exercised in deciding whether future conditions may warrant the change.

VICE-PRESIDENT ANGIER: Is there any further discussion?

MR. PERSHALL: Mr. President, in the preparation of a paper some time ago for the Cross Tie Bulletin there were some figures used therein in which no interest charges were anticipated in computing the annual cost of cross tie maintenance. A number of the members of the Wood-Preservers' Association and of the Tie Producers Association took some exception to that basis of figuring. However, even before the article was published an investigation has been made as to the actual accounting practice of railroad corporations as to how they figure their cross-tie maintenance. We may theorize all we please, but we go to our accounting department to find out how much money we have in the bank. Mr. Hendricks' paper is what we think should be developed from an entirely technical and theoretical development of this subject. I believe that on the basis of abstract theory that Mr. Hendricks' paper is sound and correct. I believe from the standpoint of actual practice and the standpoint of practical application that Mr. Hendricks' paper has no standing. Further, than that, to illustrate that there is quite a variance of opinion, we have Mr. Harrington Emerson's paper which figures simple interest and taxes. We have Mr. Hendricks' paper which figures compound interest and no taxes and I have a letter here from my good friend, Mr. F. J. Angier, (who always takes the liberty of correcting me because one time when I was quite young I used to be a draftsman for him) (laughter). Mr. Angier figures, I believe, simple interest and no taxes. In other words, here are three men respected in the industry who have three different ways of figuring and three different ways of handling interest charges.

Carrying this problem to a point where we have to use logarithms, (and if you are talking to a contractor and used logarithms you are talking entirely over his head,) to determine what is the annual cost of ties I think is carrying it to a degree that the facts in the case do not warrant. The interest charges vary from even as low as two per cent up to practically anything else that they have got to pay for getting their securities on the market. Mr. Emerson says seven. I would say their money costs the railroads lots of times nine and ten. There is a wide variation in the interest charges allowed. Who is here that can say exactly how long a zinc treated tie will last, who can say exactly how long a creosoted tie will last, or who can say how long a white oak tie will last. There is sufficient variation in the factors used in making up that formula to defeat the intent and application of any interest charges. I do not see any use in making a very complex, and intricate matter out of something that could be very simple. In other words, there are probably three ways of figuring this problem, as shown by Mr. Hendricks and Mr. Emerson and Mr. Angier, but there are quite a number of others who very properly do not figure interest charges at all on account of the complexity of the situation.

I wish to present here this problem in barest simplicity. Before writing this paper we had addressed this problem to the accounting department of the Interstate Commerce Commission. I also took up the matter with the Wabash, Milwaukee, Pennsylvania, and a few other roads. I have some of their answers here, but I believe the Interstate Commerce Commission's answer is probably to be taken as unbiased and uninfluenced by any particular corporation judgment.

T. J. MOSS TIE COMPANY
St. Louis, Mo.

December 30, 1922.

MR. ALEXANDER WYLIE,
Chief Examiner, Interstate Commerce Commission,
18th & Pennsylvania Ave., Washington, D. C.

Dear Sir:—

In preparing a paper on Annual Costs of Cross Ties, the question of the principle of accounting has come up for discussion, involving the propriety of charging, as an element of annual cost, the interest on investment and the taxes.

In order that the question might be specific, I am taking the liberty of herewith attaching a statement of the two ways it has been suggested to compute these annual costs, and am referring same to you with request for information as to the actual manner in which the annual cost of cross tie maintenance is computed in actual practice.

Would you please be advised that there is nothing involved in this question, that it is purely hypothetical, and such information as you would care to give would of course be used no further than to illustrate the principle of accounting as above referred to.

Yours truly,
(Signed) E. E. PERSHALL,
Vice-President.

Problem

Assume that a railroad is using cross ties giving an average life of 10 years; that the road has 3,000 ties per mile of track, and that the cost of each tie placed in the track is $1.00. Each year there must be inserted 300 new ties per mile. Which of the following methods would be followed in ascertaining the annual charge for cross ties per mile of track?

A—3,000 ties per mile, 10 year life, or 300 ties per year cost in place $1.00 each	$300.00
Annual charge per mile for cross ties	300.00
B—3,000 ties per mile, 10 year life, or 300 ties per year cost in place $1.00 each	300.00
6% interest on average investment for ties of $3,000.00 per mile	180.00
1% Taxes on $3,000.00 (as above)	30.00
	$510.00
Annual charge per mile for cross ties	$510.00

The 6% and 1% may be assumed to be proper rates of interest and taxation.

E. E. PERSHALL

MR. PERSHALL: That, gentlemen, is a matter of figuring the cross tie maintenance in the way of method B as favored by Mr. Hendricks, and in the way that Mr. Harrington Emerson says is the proper way to figure cross tie maintenance. In other words, there is a difference between $300 a mile and $510 a mile. Which of those two figures are correct? There is quite a substantial difference. They paid $300 that year for cross ties to maintain that mile of track. Now Mr. Emerson, Mr. Angier and Mr. Hendricks say that the cross tie maintenance per mile is somewhere in the neighborhood of $510 a mile, depending on how you apply interest and taxation. The Interstate Commerce Commission's answer to this question is as follows:

INTERSTATE COMMERCE COMMISSION
Bureau of Accounts
Washington

January 31, 1921.

MR. E. E. PERSHALL,
Vice President, T. J. Moss Tie Co.,
St. Louis, Missouri.

Dear Sir.—

Receipt is acknowledged of your letter of December 30th wherein you state that in the preparation of a paper on "Annual Cost of Cross Ties" the question of accounting has arisen which involves the propriety of charging as an element of the annual cost of cross ties, the interest upon the amount invested therein and proportion of taxes applicable thereto.

The Uniform system of accounts prescribed by the Commission does not permit nor take cognizance of interest on investment as an element of expense, includible in the computation of the maintenance costs of a carrier. The return which a carrier earns on its total investments during a year is represented by the net results of its operations, or in other words, is reflected in the amount which represents its net income for that period. The assignment thereof to the component parts of the investment account of a carrier as a whole is not done as the burden of specifically allocating to each and every unit which is included in the investment account its equitable proportion applicable thereto, would be sufficient to demonstrate the impracticability of such a plan.

Taxes payable by a carrier in connection with the operation of its railway property are chargeable to an income account provided for taxes, the identity of this account as an individual factor of cost being maintained, as the plan of charging the same to individual classes or units of property upon which taxes are assessed is not feasible.

The Commission does not recognize interest on investment or taxes as an elementary factor in reckoning costs of cross ties.

Yours very truly,
(Signed) ALEXANDER WYLIE,
Director.

VICE PRESIDENT ANGIER: Is there any further discussion on this paper.

MR. GOLTRA: I believe that Mr. Hendricks is right and Mr. Emerson is wrong. The only use we can have for the formula is to demonstrate the economy effected by using treated material. That can be done by calculating the "annual cost of maintenance" of both treated and untreated material, and the difference between the two will be the "saving" effected. We are often asked: What economy can be effected by using treated ties, poles or mine material? How much longer will treated material last, What is the relative cost between untreated and treated material in place? Does it pay to treat ties and other materials? When the questioner is told that treated ties will last on an average more than twice as long as untreated ties, and the cost of the former, laid in the track is only about 25 per cent more than the latter, laid in the track, he can figure roughly that the saving effected would be between 30 and 40 per cent, but by means of the formula we can determine the same with a greater degree of accuracy. The formula is based on compound interest, for by raising the factor "R" to the nth power, as I will show presently on the blackboard, we are compounding the interest.

In order to determine the relative economy of treated and untreated material it is first necessary to ascertain the annual charge "A" for each of the two kinds of mterial under comparison. To calculate each case separately according to the formula would be a tedious and laborious task, but there are tables available to facilitate the computation. Tables which enables one to solve any problem quickly and accurately. They can be found in various publications; they are as old as the interest tables. I note that Mr. Hunt has included the table in his paper to be presented at this meeting, the title of which is: "Why preserve mine timbers?" I believe this is the first time that the table has ever been published in our proceedings, and it ought to be very useful to the members of our association. Mr. Hunt uses the table to determine the relative economy and untreated mine material. Let us apply it to cross ties in the following example:

Assuming that a white oak tie untreated costs $2.37, laid in the track and will last nine years; interest on investment 6 per cent. The annual charge will be found by multiplying the investment of $2.37 by 0.148, equals 25 cents a year. Assuming that a red oak treated tie costs $2.86, laid in the track, and will last sixteen years, interest 6 per cent; the annual charge will be found by multiplying the investment $2.86 by 0.098, equals 28 cents a year, or a saving of 7 cents a year is effected. Multiplying this saving by the mean number of years which is 12½, gives 87½ cents in favor of the treated tie—or about 37 per cent of the cost of the untreated white oak tie, laid in the track.

By way of parenthesis I desire to emphasize the fact that a reduction of seven cents per tie, per year, in the annual cost for maintenance means a saving in round figures of about $250 per mile, or $25,000 for every 100 miles of track, *annually.*

That is what is meant by the "relative economy" of treated and untreated ties, and it is ascertainable by means of formula C. Substituting the above values of C, R, and N in the formula the equations would look like this:

$$A = 2.37 \times \frac{(1.06)^{9} \times .06}{(1.06)^{9} - 1} = 28 \text{ cents.}$$

$$A = 2.86 \times \frac{(1.06)^{16} \times .06}{(1.06)^{16} - 1} = 35 \text{ cents.}$$

The formula and table can also be used to calculate the relative economy between plain and butt treated poles, for example:

Suppose a cedar pole of 8 inches in diameter at top, 45 feet long costs $17.50, f. o. b. car at destination. Setting in place complete $10.50, total $28.00, and lasts 14 years, interest on investment 6 per cent; the annual cost of maintenance will be multiplying $28.00 by 0.107, which equals $3.00 a year Suppose that same pole is butt treated at an additional expense of $2.55, and lengthens the life 10 years; the annual cost would be found by multiplying the investment of $30.55 by 0.079 equal to $2.41 a year. The difference between the two would be 49 per cent a year. Multiplying this saving by mean number of years, which would be 12, would give $5.88 per pole, or a saving of 21 per cent of the cost of untreated pole in place.

It should be borne in mind that the formula is merely an instrument to determine the relative economy between treated and untreated material, whether it be ties, poles, mine ties, props, and timbers of any kind, and for little or no other purpose so far as wood preservers are concerned.

MR. TAYLOR: This is a very important question, and I would like to know whether Mr. Goltra would be willing to take the blackboard at one-thirty and explain just how he works the formula.

MR. GOLTRA: Yes, surely.

VICE-PRESIDENT ANGIER: Thank you very much, Mr. Goltra. If there is no other discussion on this paper we will pass to the next one by Mr. Pershall, on the subject, "Factors Affecting the Cost of Treated Cross Ties."

MR. PERSHALL: Mr. Chairman, as far as I am personally concerned, if the convention as a whole is perfectly willing to pass over this paper without reading it at all, it is all right with me. We are pushed for time, and I would like to offer that suggestion.

VICE-PRESIDENT ANGIER: Owing to the time of day and to the fact that we are considerably behind in our program, if the Association approves we will not read the paper but open it now for discussion.

FACTORS AFFECTING THE COST OF TREATED CROSS TIES.

By E. E. Pershall.

Timber Land and Stumpage Values.

The purchase of timber to be used for conversion into cross ties is largely made in two general ways, i. e.:

1. The purchase of land and timber in fee.
2. The purchase of timber only on certain described lands.

The land values on which the timber may be standing has a very direct bearing on the cost of stumpage, as timber land having a relatively high potential value for farms or ranges, in most cases carries with it taxes that are very closely related to its future use.

For example, there are certain swamp timbered areas, particularly where cypress, oak, and gum comprises the major portion of the stands, that make exceedingly rich farm lands after the timber is removed and drainage ditches constructed. These systems for drainage are state and county projects costing in the aggregate relatively large sums of money, built out of the proceeds from the sale of bonds and refunded over a term of years by taxes assessed upon all lands that are immediately or eventually benefited thereby. These drainage taxes prompt the early removal of timber, not only as a source of ready cash to the owners, but mainly to hasten the day when the land becomes at least tax supporting.

Estimating the Value of Timber.

Values of timber and timber lands, as may be used for the manufacture of cross ties, are in most cases determined by experienced timbermen, who are not only expert at estimating the amounts of the various kinds of timber standing, but much more importantly the numerous considerations involved in the profitable removal of the timber from stump to river bank or railroad.

The amount of labor in the immediate territory available for carrying on the making and hauling of ties, the character and topography of the timberlands, which always affects most directly the amount of the standing timber that will be actually removed at a reasonable cost, the length and character of the haul to the railroad or river bank; the cost of driving, rafting, or barging from river bank to railroad, where necessary; and the freight rates from prospective shipping points to certain large rate basing points, such as Cairo, Thebes, St. Louis, Kansas City, Chicago, Louisville, Cincinnati, etc.; all very pertinently enter into the proper valuation of a profitable timber investment.

For example, investments in an exceedingly large tract of timber in a sparsely inhabited territory may require so long a time to complete the conversion of timber into cross ties as to make interest charges, taxes, storm losses, and slow turnover quite a factor in the cost of stumpage.

Ties per Acre of Timber Land.

In the Mississippi Valley territory the stands of virgin oak timber rarely cut out over one hundred 6" x 8" x 8' ties per acre on the average, and in the majority of instances an actual production of fifty oak ties per acre is considered a very good average.

Cypress brakes, when converted exclusively into cross ties, will cut out a much larger average number of ties per acre than oak, but cypress trees of the larger diameter are generally valued by lumberman at much higher prices than the tie man can afford to pay.

Various Species of Timber and U. S. R. R. A. Specifications.

Prior to the existence and general acceptance of the cross tie specifications of the United States Railroad Administration, a very substantial amount of standing timber of such species as hickory, ash, elm, maple, gum, and pine, that always grew on timber lands together with white and red oak, were left standing, in many cases, to the ravages of decay, fires, winds or the girdling of the future farmer.

The general sale and purchase of cross ties on the basis of fair values for the various species enumerated, or better still, classified under the U. S. R. R. A. specifications, has done much good toward the conservation of timber through prompting the timely conversion of species other than oak into cross ties rather than allow a very substantial percentage of good sound trees of these species to lapse into the category of cutover lands and thereafter to eventual waste.

Conversely, the very rigid wording and application of the specifications as to defects has taught the tie man the futility of attempting to work up trees that have been fire scarred or wind shaken, and the number of trees that have suffered from ground fires, particularly in open range country, at one time or another, is very much larger than is commonly appreciated.

Manufacture of Cross Ties.

The manufacture of cross ties, after felling the tree and cutting the bole into eight foot or multiple logs, is accomplished by hewing or sawing.

In making hewn ties, logs over 14 inches in diameter are split, by means of tie wedges, into two, three, four or more sections, roughly dimensioned for hewing with a broadaxe into cross ties.

Logs under 14 inches in diameter may be hewn on two faces, and some times on two sides, into one of the five grades of cross ties provided in the specifications. For example, for logs perfectly round and straight:

12	to	14	inch diameter logs may be hewn to	7x9	Grade	5
11	"	12	" " " " " " "	7x8	"	4
10	"	11	" " " " " " "	7x7 6x8	"	3
9	"	10	" " " " " " "	6x7	"	2
8½	"	9	" " " " " " "	6x6	"	1

The hewing of cross ties is at best but a rough wood-working operation that cannot, in the majority of instances, be carried on within a restricted tolerance of dimensions, and a broadaxe in the hands of a steady and skilled tie maker must some times deviate from straight lines and parallel faces.

It can be more readily appreciated, therefore, that the average tie maker may be somewhat condoned for failing to hew to the straight lines along the four corners of the tie, ending up with a cross tie a grade or two lower than the diameter of the log might have originally indicated.

An attitude of appreciation of these unintentional slips of the tie maker's broadaxe on the part of the railroad inspector who ultimately grades the cross ties for the basis of invoice is called "the exercising of some judgment" by the majority of our best tie men, but the justification therefor does not by any means meet with the universal approval of quite a number of our foremost railroad officials, timber engineers and foresters.

The manufacture of cross ties by saw mills is generally done in the Mississippi Valley territory by the use of so called "portable tie mills." After the tree is felled and bucked into logs, teams and log wagons haul 3 to 5 logs per load to the mill set, where same are later sawed into cross ties and one inch thick lumber, commonly called "tie siding."

Tie Siding.

The price obtainable for this tie siding is a very important factor affecting the cost of the cross tie, but fortunately, or unfortunately as the case may be viewed, the prices for tie siding are always highest when cross ties are finding a ready market, and the siding can hardly be sold at all when cross tie prices are depressed.

Ties Lost in Woods.

During periods when the roads become impassable, or during periods when teams are difficult to obtain, hewn ties are not always hauled out of the woods in time to prevent deterioration and loss. These losses are mainly due to ground fires, high water, and as much as anything else to the sap rot that all too frequently attacks a cross tie, if left lying on the ground surrounded and partly covered by weeds and underbrush in a warm swampy country.

The tie man is indeed fortunate if the total number of ties shown as "made" on payroll accounts always check out favorably with the number of ties shown as "hauled," and that such eventualties directly affect the cost of the number of ties shipped must be clearly apparent.

Hauling of Cross Ties.

The hauling of cross ties out of the woods when hewn, or from mill yards where sawed, is accomplished in by far the majority of instances by teams and wagons.

Comparatively large investments have been made in motor trucks, tractors, both steam and gasoline, to do this work, but neither trucks nor tractors show any particular advantages when compared to horses or mules, when the comparison covers the many road and ground conditions that are encountered. An average load (wagon) of oak ties in the Mississippi Valley territory is twelve to fourteen 6" x 8" x 8', depending on roads, hills, and the kind of animals used.

All cross ties are hauled either to a railroad right of way for inspection and loading, or to a river bank for driving, rafting, or barging to a railroad some distance away from the point of production.

Water Transportation.

The mode of transportation by water depends largely upon the character of the stream to which the ties have been hauled. On comparatively small, clear, shallow streams ties may be driven, that is rafted singly, to the greatest advantage. Some notable tie drives, running into hundreds of thousands, are those on Wind River in Wyoming, and on Black River in Missouri.

On streams where the water is not clear, or the depth too great, for driving, but where not deep or wide for barges and steamboats, the ties are nailed together into sectional units of 8 to 12 ties, and these units are made up into rafts of one, two, or three layers deep; bound together ingeniously by a "guiding pole," and are floated down stream, guided either by gasoline towboats, simple wood sweeps, or crude rudders. Where bottom can be reached by means of long poles, the raftsmen guide the ties around bends and curves by sticking the end of the pole in the bottom of the stream, and then walking on top of the raft in a sort of treadmill fashion makes the raft, with its various sections, follow the serpentine curves of the stream.

In the two foregoing operations, an element of risk, always to be encountered, is the condition of the stream at the time of driving or rafting. In driving, if the water is too low the time of the crews per mile of travel makes the expense much greater, and also causes more "dead heads" or "sinkers," due to the increased absorption of water in a given distance of travel.

Conversely, ties being transported on driving water may be floated out of the normal banks of the stream and back into the woods and brush, and even into the tops of trees, by hard rains and floods finding their natural drainage down relatively narrow and steep watersheds.

In rafting, a large expense is labor, and nails for binding strips, as compared to driving, and, in addition to water losses due to causes already referred to in driving, is the breaking up of rafts due to the swift water arising from rains, and to the sinking of rafts caused by an accumulation of mud that washes up on the tops of the ties. Brooms are generally carried by the rivermen to sweep the mud off the tops and from in between the ties, as much as possible. Another peculiar loss, in the rafting of ties where the water is rough, arises from the undulating wave motion working the raft up and down in sections, so as to pull out the nails holding the binding strips.

Some large rafting operations are those on Current River, St. Francois River, Duck River, Tennessee River, and Cumberland River.

These foregoing water losses are obviously largely avoided by barging the ties from river bank to railroad on those streams where barges and towboats may operate. Here the ties are skidded in chutes from river bank into barges holding from 2,000 to 10,000 ties. A tow of from 3 to 7 barges is made up and guided down stream in most instances by a steam operated towboat to some river port giving connections with a railroad.

River Ports.

At these ports very substantial investments have usually been made in providing inclines, switching facilities, and a towboat for the transfer of loaded and empty barges about the incline, to the end that the ties may be loaded barge to cars for shipment to point of consumption.

Towing Ties.

The maintenance of towboats, barges, etc. is a costly venture wherein the unit costs of towing per tie are dependent largely upon four major items, viz.: fuel, labor, repairs, and number of ties hauled with a given investment in equipment. The great common denominator of the volume of business handled with a given fleet of boats and barges plays quite as important part in the unit costs of towing as does this same factor of volume affect the costs of treating ties with any given treating plant investment.

Loading Ties on Cars.

Ties reaching a railroad siding by rafting, driving, barging, or hauling, are loaded onto cars for shipment very largely by one of the three following ways:

1. Tie handlers—manual labor.
2. Endless chain or cable conveyors.
3. Locomotive crane.

Where there is a limited amount of separation of grades and species of timber to be done, and a substantial number of ties to be loaded, mechanical loaders are generally much more preferable than tie handlers. In a large majority of instancs, however, the handling of ties onto cars for shipment is closely connected, and is in reality a part of the sorting into grades, and where this is to be done a negro tie handler is economically superior to any mechanical devices now in common use.

The cost of loading of course varies largely with the kind of work to be done. For example, ties without any separation as to grades or species may be loaded with a locomotive crane out of the river onto cars for so low a charge as twenty-five cents per hundred ties, when handled in good volume. From this low extreme, the cost may vary up to six or seven cents per tie for complicated separations as to grades and species and depending upon method of loading employed.

The cost of supervision is obviously greater with the increased complexity of the operations involved and directly proportional to the volume of business handled.

Freight.

One of the largest factors entering into the cost of the treated cross ties is freight. These transportation charges, as at present in effect, are quite double the legal tariffs in effect for identical services in 1913. Cross ties are a relatively low priced commodity when figured on the basis of weight and values at point of shipment, so that the rate of freight to point of use often amounts to more than the first cost of the cross tie at point of production.

The character of the freight rates used is of course the result of years of evolution in the matter of freight rate structures, but they are generally based upon a per cwt. or a per tie basis. In the absence of specific rates on cross ties, the rate of freight applicable on rough lumber of the same species is generally effective.

The use of local rates from point of origin to treating plants, and local rates out of treating plant to destination are not generally used, except at rate breaking points, such as river crossings, where, for certain reasons, the combination of locals together with particular conditions defining the movement from point of origin to treating plant, and treating plant to destination, give a more advantageous arrangement than treating in transit on the basis of through rates from original point of origin to destination.

It is further obvious that as cross ties are purchased in the largest extent by common carriers, that the question of routing and billing is a very important factor entering into the cost of the treated cross tie, particularly where there are usually four or five junction points available, and as many different arrangements for determining the foreign lines proportions up to such junction points.

The possibilities offered for selection of the most advantageous basis of freight rates to use in any particular case is indeed one of the most interesting and important features connected with the cost of delivering cross ties to common carriers.

Inspection.

Cross ties are usually inspected in the field as loaded on cars for shipment, both for grade and species. There is probably no one element affecting the cost of finished cross ties as much as the matter of inspection. It is unfortunate that the variation in the inspection of cross ties has always been a condition very difficult to anticipate with any degree of certainty.

Probably the greatest national opportunity for standardization of cross tie inspection was during Federal control of the railroads, when all cross ties were being purchased by the roads under the same specifications and standard rules for application of these specifications, giving variations, etc., were in effect, and yet the difference in inspection on the same kind of cross ties between the Southern, Southwestern, Central Western, and other regions, were so great as to call for many adjustments and compromises.

Obviously, the grading of cross ties will never become an exact science, and inspection will, for some time in the future, be a large controlling influence on the cost of cross ties of the various grades, in so far as the inspection determines these grades, after all moneys have been spent in the production of ties.

In short, the aggregate investment required to produce a specific number of cross ties, that may be later offered to an inspector for final grading, is a definite sum of money, fixed and absolute. The inspection and grading of cross ties, however, is a variable factor, depending very largely upon the personal element or elements that help to affect the application of the specifications in each instance, and thereby the grading of the ties becomes a most important factor in determining not the cost of the total number of ties produced, but most pertinently the cost of each grade.

Treatment.

The cost of preservative treatment of cross ties depends largely upon four items:

1. Labor.
2. Fuel.
3. Overhead, including, among other items, repairs, maintenance, and depreciation.
4. Cost of preservative.

Unit costs based upon the first three items are inversely proportional to the volume of business handled with any given plant investment.

The cost of domestic creosote oil is very closely connected with conditions in the steel industry, as the manufacture of coke, is controlled by the output of the steel mills. The by-product tar, from the manufacture of coke, from which creosote oil is obtained, is again valued in comparison to the petroleum fuel oil, as either fuel oil or coal tar may be used by the steel manufacturers with satisfactory results.

The cost of zinc chloride is closely related to the market price of spelter, as spelter is largely made from zinc blend, from which sulphuric acid is a by-product. The sulphuric acid, together with salt (sodium chloride) are the raw materials for the manufacture of muriatic acid, which in itself is a raw material used in the manufacture of zinc chloride. It may be proper to mention here that while the cost of zinc chloride is very closely related to the market price of spelter, the selling prices for zinc chloride do not always bear out any direct relationship.

Selling Arrangements.

The sale of cross ties, either untreated or treated, as the buyer may elect to purchase, is generally done by negotiation, and contracts are usually made based upon:

A. Flat price for a specific number of ties.
B. Cost-plus arrangements.

C. Periodical price adjustments in line with market conditions.

Method C is but a continuation by mutual agreement of method A. Method B is self-explanatory as to principle. Cost-plus arrangements have several advantages in avoiding any substantial losses to the manufacturer due to rigid inspection or adverse market fluctuations, but usually requires. a system of strictest accounting, which, under certain conditions, may be quite unwieldy.

Payment.

Terms of payment usually specified on sales of cross ties are thirty days net cash, and it might as truthfully be said that these terms are generally interpreted by the railroads with exercising of considerable discretion. Slow payment means increased interest charges and decreased production with a specified amount of capital. However, this handicap, like others incident to the many details connected with the business of producing, shipping, treating, and selling cross ties, softens with the repetition of the same kind of experiences.

Profit and Loss.

All references hereto have been made to the factors affecting the cost of the treated cross tie. It must be distinctly understood that "cost" is a very different item in accounting than "price." With exception of those selling arrangements where a profit is guaranteed by the buyer as a part of the selling price, the tie man must be prepared to stand or fall upon the actions of the law of supply and demand. For the past year those producers carrying the largest inventories generally wore the longest faces, while the year previous large inventories had certain well defined advantages that made for smug looks and warm smiles.

VICE-PRESIDENT ANGIER: Is there any discussion on this paper? Mr Brown, can you discuss this paper of Mr. Pershall's?

MR. BROWN: I have nothing to offer.

VICE-PRESIDENT ANGIER: Mr. Walsh, I believe you have something to say.

MR. WALSH: Well, I haven't very much to say on the paper. As the President of the Company with which Mr. Pershall is connected, once said, It doesn't take very much brains to be a tie man, but it takes a peculiar one. [*Laughter*] But with all the small amount of brains and peculiarities connected with the business, it has been a pretty hard drag the past few years. Mr. Pershall has been kind enough here to go into details, and he has practically covered all the operations of the tie industry, from the stump to the car. However, he did not take into consideration or make any comments on the cost of carrying this timber. Many of the tie companies, for a good many years, have carried timber that was purchased perhaps at from $5 to $10 an acre. Compounding interest on a $6 piece of land which has been held for 18 years and which it was estimated to produce 75 ties to the acre, would be equal to 8 cents per tie on the stump. Today this would be around 22 cents. Well, the price of ties in the past year or two have been up, but they are back to about 22 cents today, so that the tie men have gotten to a point where they are not in a position to manufacture any timber that has been carried for any number of years. In fact they cannot produce ties today at the prices that are being offered, not taking into consideration the timber at all.

This brings on another vital part for those who are interested in creosoting plants in a commercial way. The railroads have been forced or have collectively discontinued the taking of ties. Consequently the production is not any more than 25 per cent of normal. Well, a great many plants are well supplied today with dry ties, perhaps until the middle of the year, but what we are going to do for seasoned ties after that time I am unable to say. I think it is a matter that is of vital importance to the carriers as well as the tie producers. Something should be done to bring about a stabilization of the prices of ties. The quality of ties required for railroads is practically equal, so far as maintenance is concerned, each year, and if the railroads could be gotten together on a basis whereby such requirements could be anticipated in advance it would help materially to stabilize the price. The same would apply also to the cost of treating, not only with the commercial plants, but also with the company owned plants.

Mr. Pershall here has covered the cost of treating and has taken into consideration the four items which practically cover the cost of creosoting or preserving timber, but if a plant is operated only three months in the year against its full capacity it increases the cost of the timber preserving materially.

VICE-PRESIDENT ANGIER: Gentlemen, this is a most interesting paper. Mr. Pershall has brought out the points from the tree to the time the railroad buys the tie. We have a number of tie producers here and we have about fifteen minutes left to discuss this paper. We would like to hear from some of them. Is there any further discussion?

Mr. Goltra has very kindly consented to show you his formula on the blackboard at one-thirty. I am sure you will be interested in getting back here at that time to hear Mr. Goltra's further discussion. Gentlemen, we will adjourn until two o'clock this afternoon, and I will ask you to please be here promptly at that time.

A recess was then taken till two o'clock p. m.

WEDNESDAY AFTERNOON SESSION

January 25, 1922

The meeting was called to order at two o'clock p. m. by Mr. Taylor, the President.

THE PRESIDENT: We will have a report on the Service Bureau, an activity started last year of which the Association should feel very proud. I take pleasure in giving Mr. Crawford this opportunity to tell of the Service Bureau Board as to their past and more as to their future. [*Applause.*]

REPORT OF COMMITTEE 3—SERVICE BUREAU BOARD

To the Members of the American-Wood Preservers' Association:

At the January 25, 1921, meeting of the association the following motion was made by President Joyce, seconded by Mr. J. H. Waterman, and carried by the vote of the convention:

"That the following Service Bureau Board be established: C. G. Crawford (Chairman), Walter Buehler, L. J. Colman, L. C. Drefahl, R. S. Manley, G. B. Shipley, and E. J. Stocking, with duties as follows:

"1. To complete the campaign to finance the Service Bureau.
"2. To engage a competent executive and establish a central office.
"3. To direct the work of the Service Bureau for the 3-year guarantee period.
"4. To administer the finances of the Service Bureau.
"5. To report to the association through its Executive Committee."

At the first meeting of the Service Bureau Board held in San Francisco on January 26, 1921, arrangements were made to continue the campaign for pledges until the specified minimum amount had been subscribed. Since the San Francisco meeting six meetings have been held in Chicago, on March 14, May 17, July 7, September 20, December 6, 1921, and January 23, 1922, respectively.

After the required minimum amount believed necessary to establish the Service Bureau had been subscribed, Mr. P. R. Hicks was appointed Secretary-Manager and Mr. E. J. Stocking, Treasurer. Offices were established on July 1, 1921, at 1146 Otis Building, Chicago, and the work of the Bureau is being conducted under the direction and supervision of the Board according to the following rules of procedure approved by the Executive Committee of the American Wood-Preservers' Association:

ARTICLE I—NAME

This Department shall be known as the Service Bureau of the American Wood-Preservers' Association.

ARTICLE II—OBJECTS

To promote the use of wood which has been prepared to resist decay, and thereby conserve the forest resources of the nation.

To establish and maintain offices which shall be a repository for all information regarding the practice of and the results from the art of wood preservation and which shall utilize this information in all efficient ways to disseminate this knowledge and to develop the understanding of the public as to the economic status of the wood-preserving industry.

ARTICLE III—MEMBERS

Any individual who is a member of the American Wood-Preservers' Association, any organization which has representation in the American Wood-Preservers' Association, shall be eligible to membership in the Service Bureau, provided such individual or such organization contributes annually to the support of the Service Bureau an amount satisfactory to the Service Bureau Board.

ARTICLE IV—SERVICE BUREAU BOARD

A: The affairs of the Service Bureau of the American Wood-Preservers' Association shall be administered by a Board consisting of seven members of the Bureau, as set forth in motion adopted at the Seventeenth Annual Convention of the American Wood-Preservers' Association. This Board shall elect from its membership a Chairman and a Treasurer. The Board shall retain from without its membership a Manager who shall serve as Secretary to the Board.

B: At the expiration of the term of the present Board succeedceeding Boards shall be elected by the Executive Committee of the American Wood-Preservers' Association.

C: Vacancies on the Board, from any cause whatsoever, shall be filled by the Board, subject to the approval of the Executive Committee of the American Wood-Preservers' Association.

D: Any member of the Board may be removed for cause by a majority of the Board, subject to the approval of the Executive Committee of the American Wood-Preservers' Association.

ARTICLE V—DUTIES OF THE TREASURER

The Treasurer shall collect and be responsible for all funds. He shall give bond, in amount not less than $10,000.00. All expenditures of money not exceeding $100.00 shall be made in voucher form, signed by the Secretary and countersigned by the Treasurer. All expenditures of money in amounts exceeding $100.00 shall be made in voucher form, signed by the Secretary and countersigned by the Treasurer, upon authorization by a majority of the Board.

The Treasurer shall make a detailed financial statement, properly audited, at each regular meeting of the Board.

ARTICLE VI—SECRETARY MANAGER

The Secretary-Manager shall have charge of the offices of the Board and shall conduct the affairs of the Bureau in a manner satisfactory to the Board. He shall be responsible for the detailed operation of the Bureau, but shall at all times be governed by the policy as from time to time determined by the Board.

ARTICLE VII—MEETINGS OF THE BOARD

The Board shall meet in the offices of the Bureau or at such other place as designated by the Chairman at least once in every ninety days.

Special meetings of the Board shall be held whenever called by the Chairman, or by the secretary upon the written request of three members. Any and all business may be transacted at any meeting, unless in the case of a special meeting it is otherwise indicated in the notice thereof. At any meeting at which every member shall be present, even though without any notice, any business may be transacted. Any action of a majority, although not at a regularly called meeting, if assented to in writing upon the record thereof by all the other members of the Board, shall always be as valid and effectual in all respects as if passed by the Board in regular meeting assembled.

At any meeting of the Board the presence of four members shall be necessary to constitute a quorum.

ARTICLE VIII—AMENDMENTS

These rules of procedure may be amended at any time by a two-thirds vote of the members of the Board and with the approval of the Executive Committee of the American Wood-Preservers' Association. provided notice of the proposed amendment shall be given in writing to the members of the Board at least thirty days prior to the meeting at which the same shall be acted upon.

The Service Bureau has been made possible by the contributions of the following 37 members of the association, and especial care is being taken to show no discrimination against or favoritism toward any particular company, its products, or processes:

Allis Chalmers Manufacturing Company, Milwaukee, Wis.
American Creosote Works, Inc., New Orleans, La.
American Creosoting Company, Inc., Louisville, Ky.
Colonial Creosoting Company.
Federal Creosoting Company.
Georgia Creosoting Company.
Indiana Creosoting Company.
Shreveport Creosoting Company.
American Creosoting Company of N. J., New York City.
American Tar Products Company, Chicago, Ill.

Ayer and Lord Tie Company, Chicago, Ill.
Barrett Company, New York City.
Bernuth Lembcke Company, New York City.
Central Creosoting Company, Chicago, Ill.
Century Wood Preserving Company, Pittsburgh, Pa.
  Michigan Wood Preserving Company.
  Ohio Wood Preserving Company.
  Pittsburgh Wood Preserving Company.
Chatfield Manufacturing Company, Cincinnati, Ohio.
Colman Creosoting Works, Seattle, Wash.
Compressed Wood Preserving Company, Cincinnati, Ohio.
Creosoted Materials Company, Inc., New Orleans, La.
Grasselli Chemical Company, Cleveland, Ohio.
Indiana Zinc Creosoting Company, Chicago, Ill.
International Creosoting & Construction Co., Galveston, Texas.
Jennison-Wright Company, Toledo, Ohio.
Johnson and Son, Richmond, Ind.
Kettle River Company, Madison, Ill.
Lewis Manufacturing Company, Chicago, Ill.
Long-Bell Lumber Company, Kansas City, Mo.
McCormick, Chas. R., and Company, San Francisco, Cal.
Midland Creosoting Company, Granite City, Ill.
Monsanto Chemical Works, St. Louis, Mo.
Moss Tie Company, St. Louis, Mo.
Nashville Tie Company, Nashville, Tenn.
National Lumber and Creosoting Company, Texarkana, Texas.
National Pole Company, Escanaba, Mich.
Pacific Creosoting Company, Seattle, Wash.
Pioneer Lumber and Creosoting Company, Ensley, Ala.
Rodd Company, Pittsburgh, Pa.
Savannah Creosoting Company, Savannah, Ga.
Southern Creosoting Company, Slidell, La.
Southern Wood Preserving Company, Atlanta, Ga.
Watkins Creosoting Company, Chicago, Ill.
Western Tie and Timber Company, St. Louis, Mo.

The activities of the Service Bureau have been concentrated along the following lines:

Wood preservation exhibits at national and local conventions.

Participation in the discussion and presentation of papers on wood preservation at meetings of engineering and other associations.

Special lectures on "The Preservative Treatment of Wood and the Use of Treated Wood for Construction Purposes" at engineering colleges.

The preparation of articles on wood preservation for publication in engineering and trade journals.

Cooperation with various associations and individuals on wood-preservation problems.

The exhibits have been viewed by many thousands of people from all parts of the country and should be of considerable value in bringing the advantages of well-treated wood to the attention of various classes of people.

Addresses have been given at conventions on the treatment and use of treated bridge timbers, mine timbers, ties, piling, paving, and structural timbers for various uses.

Sixty-one requests for lectures at engineering colleges have been received from 43 states. To date 17 lectures have been given in the states of Illinois, Minnesota, New York, Georgia, Florida, Louisiana, Pennsylvania, Ohio, Virginia, Arkansas, Texas and Iowa. Fourteen lectures have been definitely arranged for, and tentative arrangements have been made for the thirty remaining.

Articles on wood preservation have been published in magazines of various kinds. Some of the articles published during the past few months and the magazines in which they were published are exhibited.

Your Committee has kept in close touch with developments and knows that excellent progress has been made in promoting the use of treated wood, especially when it is considered that the Bureau was established only six months ago.

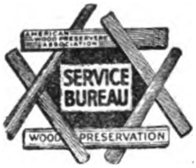
The success of the Service Bureau depends not only upon the work of the Board and the Manager, but upon the cooperation of each member of the association. We greatly appreciate the cooperative spirit shown by members of the association, especially those employed by the various railway systems, and members of companies who at the present time are not members of the Service Bureau.

CARL G. CRAWFORD, *Chairman*
WALTER BUEHLER
L. J. COLMAN
L. C. DREFAHL
R. S. MANLEY
GRANT B. SHIPLEY
E. J. STOCKING

MR. CRAWFORD: That is our formal report to the Association, but I want Mr. P. R. Hicks, the Secretary-Manager of the Bureau, to give in a little more detail the work that has been accomplished in the last six months, during the time he has been in office.

MR. HICKS: A short time after the Service Bureau was established an announcement giving a brief outline of our activities and a list of members was prepared and sent to each member of the association with a letter soliciting your cooperation. I am glad to state that we have had very excellent cooperation from all of you. A copy of the announcement was sent to about 170 technical and trade publications, including engineering, mining, telephone, electric, railway, lumber, commerce, export, architectural, contracting, and farm journals, and others, with a letter inviting their cooperation. Their response was gratifying, and notice of the establishment of the Service Bureau appeared in many papers throughout the United States and in some foreign countries. Announcements were also sent to many associations and individuals interested in preservative treatment and the use of treated wood. A great many requests are received for information on this subject, and, in fact, a large part of our time is taken up in answering these inquiries.

A trade mark or emblem of the Service Bureau was designed, and it is presumed you are all familiar with it. Here it is.



During the past few months we have been called upon to address meetings of several associations of national repute. Mr. C. M. Taylor spoke on "The Successful Treatment of Bridge Timbers" at the annual convention of the American Railway Bridge and Building Association. Mr. Geo. M. Hunt addressed the Mining Congress on the treatment of mine timbers. A paper on "Creosoted Timber in Port Construction" was read and discussed by Mr. Horrocks and Mr. Coleman at the annual convention of the American Association of Port Authorities. Mr. J. H. Waterman told the Roadmasters' Association about the treatment of ties and timbers. Mr. Angier prepared a report for the Southern Forestry Congress on "Wood Preservation on the Railroads." In addition to these, the use and treatment of timber in various forms were discussed informally at several other meetings.

Articles on the treatment of wood and its use were prepared for various trade journals, and we have exhibited here on the wall several hundred articles which have been clipped from various publications during the past few months. From the covers of many of these, which are also on exhibit, you will note that these articles appeared in magazines of all kinds, including the Proceedings of many associations, as well as our own.

It occurs to me that one of the most practical ways for us to bring the subject of wood preservation before men who will before long be in position to recommend the use of treated wood is to see that copies of our Proceedings are on file in the various universities, where engineering students can consult them. Some of us could do a little "missionary" work along this line. We could see that a copy is placed in the library of the university of which we are a graduate. Perhaps some of us have copies of back numbers of the Proceedings which we could donate to them.

We have cooperated with committees of various associations interested in the treatment of wood, assisting them in the preparation of reports and advising them of up-to-date practice in the treatment of wood.

Exhibits showing the use and treatment of wood were prepared for the Chicago Pageant of Progress Exposition and the National Good Roads Show. Arrangements were made for an exhibit at the American Mining Congress which was prepared and conducted by the Forest Products Laboratory and the Bureau of Mines. These exhibits consisted mainly of samples of preservatives, photographs and specimens of treated and untreated wood after various periods of service, and articles on the treatment of wood and standard specifications for distribution. An exhibit featuring particularly the use of treated material for highway construction is now being shown at the Little Rock, Ark., meeting of the American Association of Engineers.

Last January the Bureau of Public Roads issued instructions to its District Engineers in which they were requested to recommend to States in their district the elimination of timber bridges on Federal Aid projects. No mention was made of the use of well-treated timber, and these instructions were, therefore, generally construed to mean that the Government did not approve of the use of treated timber. As a result of the activities of the Service Bureau and others, the Bureau of Public Roads in September amended these instructions to their District Engineers to permit the use of well-creosoted material.

We know that by the use of well-treated wood permanent structures are obtained at a cost considerably less than if built of *so-called* permanent material. We know also that the cost of upkeep of such structures is practically negligible, and that their permanence can not be questioned. Realizing, therefore, the immensity of this field for treated material and the advantages which the public must reap from the use of this material in highway construction, an article, "Treated Timber for Highway Construction," was prepared, printed, and sent to highway officials and engineers interested in road construction problems. The article was published in several engineering, contracting, and lumber journals. That our work in this respect is bearing fruit is shown by requests received for information and assistance in drafting and revising specifications for treated material.

Through the Service Bureau and the Executive Committee of the American Wood Preservers' Association a member of the association has been appointed to act on a committee to study the problem of highway bridge floor design in an attempt to eliminate any possibly fire hazard. The committee consists of: Mr. G. W. Booth, Chief Engineer, National Board of Fire Underwriters; Mr. E. F. Kelley, Chairman of Sub-Committee on Bridge Standards of the American Association of State Highway Officials, Bureau of Public Roads; Mr. D. F. Holtman, Chief Engineer, National Lumber Manufacturers' Association; Mr. L. T. Ericson, Chief Engineer, Jennison-Wright Company. Mr. L. T. Ericson is the A. W. P. A. representative, and Mr. Holtman is also a member of this association.

Early last fall we advised the engineering schools throughout the country that we would be glad to talk to the senior engineering students on the preservative treatment of wood and the use of treated material for construction purposes. To date we have had 61 requests for such addresses, distributed through the entire country, in 43 states. Seventeen of these talks have been given; definite arrangements have been made for 14 more; and tentative arrangements have been made for the 30 remaining. These addresses have been given by H. R. Condon, Neal D. Evans, A. E. Larkin, H. J. von Leer, R. S. Manley, E. E. Pershall, S. T. Pollock, Geo. E. Rex, O. C. Steinmayer, C. M. Taylor, R. H. White, W. P. Wiltsee, and myself. An outline of a proposed lecture to engineering students was prepared for the use of speakers who did not have an opportunity to prepare an address of their own. Many members of the association have stated that they would be glad to make such addresses, and F. J. Angier, Nelson C. Brown, Walter Buehler, C. C. Fritz, W. H. Grady, C. L. Hill, Forrest Shinn, J. H. Waterman, and others, will give similar addresses within a short time.

Wood preservation plays an important part in the conservation of our forest resources by making one treated timber take the place of several untreated timbers, thereby reducing considerably the drain on our forests. Well-treated wood can be economically used, not only for railroad ties, bridge timbers, piling, poles, posts, wood block floors, paving, mine timbers, wood pipe, barge and ship timbers, and other uses with which wood preservers are familiar, but for all structural timbers, especially for the construction of wooden buildings of various types.

In his address yesterday Mr. Aishton told us that we needed a press agent. Recognition of this fact was one reason for the establishment of the Service Bureau. You gentlemen are each a part of that Bureau, and no one of you should lose an opportunity to tell about the advantages of using treated timber. Many of you are members of local engineering societies, and I doubt if many members of these societies are familiar with preservative treatment and the use of treated wood. Make it a point to discuss the treatment of wood at your regular meetings. If you can arrange to address the meeting we will be glad to furnish slides to illustrate your talk.

We are always glad to have the suggestions of each member of the association. Many of you undoubtedly come in contact with engineers and others who could use well-treated wood advantageously in places where they are now using other material. Write us about it; perhaps we have data on hand which would convince them that treated timber would be more economical. If, on the other hand, you feel that we are not attacking a problem from the right angle, do not hesitate to send us your comments and criticisms. As stated above, we have had excellent cooperation from you thus far, and we hope that we will continue to have it. [*Applause.*]

MR. ANGIER: Mr. President, I think this is an opportune time for me to say a few words. I think the Service Bureau is the best thing we ever put across. It is a wonderful thing. We want every member of this Association to help educate the people to the necessity of treating timber.

Gentlemen, think of it, in 1920 out of 50 billion feet of lumber produced in this country only about four per cent, or two billion one hundred million feet were treated. We ought to treat 20 per cent. Going back for ten years we have treated more than seventeen billion board feet of lumber, and of that seventeen billion board feet about 77 per cent was cross ties, 5 per cent piles, 3 per cent poles, and 5 per cent wood blocks, leaving only about 10 per cent for all other timber. Of the two billion board feet of lumber used for car construction in this country scarcely any of it is treated. I do not know what percentage should be treated, but perhaps a great deal of it.

I think we all ought to get back of the Service Bureau and help to educate the people to the necessity of treating timber, and we should treat more of it. Instead of one hundred plants in this country we should have five hundred. We need more members in the Association. We are going to try this year to bring this Association up to a thousand members, and when we get a thousand members, and therefore more money to further the interests of the Association, we are going to accomplish something. We want you all to pull with us. [*Applause.*]

MR. CRAWFORD: Before any other remarks are made I want to say a few words further which I feel really belong to our report. You all know that our Association has been in existence some seventeen years, and that not very much educational or publicity work has been done by the Association. This is a new project, as you all know. The members of the Board are new, the Secretary-Manager is new and the work that we have just started is new. It is in a measure on trial. The work has been going along very nicely, but I do not think that this report should be wound up without my saying something with reference to the Board which was appointed a year ago, and something of the attitude with which the Board has undertaken this problem.

It is very pleasing to me to report upon the unity of purpose, and the harmony which has characterized this Board. If ever a set of men was selected to carry on a great work who began that work with a set purpose in mind, forgetting self, and hobbies and pet theories and devoting their untiring energies to carrying out a direct project, I can say this board is a similar body of men. They have worked as one man, outlining, planning, organizing this work so as to expand and broaden out our industry, and make the industry of wood-preservation one of which we can all be proud.

Now, gentlemen, this Board, together with its Secretary Manager, cannot do it all, and do not forget that this Service Bureau is a part of the American Wood-Preservers' Association, and you are a part of it. We need the hearty co-operation and support of every member of this Association, and we are going to ask you to give us that support. I am saying that in addition to this report that Mr. Hicks has made, in which he has complimented the Association as a whole, and the individual members on the work that they have already given us, that I feel in view of that we can again ask you and impress upon you the fact that we need the hearty cooperation and the hearty support of every member of this Association. Don't forget that our offices are in the Otis Building, Chicago, and that those are your offices, and when you come to Chicago call there and find out what Mr. Hicks has been doing. He is willing and anxious at all times to give you a detailed report of everything that has been done, and I will ask you to make that a part of your headquarters in Chicago. I am saying this to the members of the Bureau and to the Association as a whole. [*Applause.*]

MR. WATERMAN: Mr. President and Gentlemen: There is not anybody that can look at this body of men but knows that they are among the best business men in this Association. I do not believe there is anybody in this Association who is unwilling to boost for them and pull for them.

Mr. Aishton said yesterday we wanted a press reporter. They are our press reporters. Now I am going to tell you a story and I will be through, and it applies to this Board. Some years ago I was up in the Black Hills, and I was walking along the track looking at some experimental ties, and down in a little creek I saw a man working, and I said: "What are you doing?" He said, "I am panning out free gold." Well, then I sat and watched him a while. He had a little pan, and he put in dirt, and he put some water in and he stirred it around and rolled it a little, and the dross and the water ran over the sides and by and by in the bottom of the pan I could see gold, traces of gold, and that is the way he was making his living, panning out gold. Now, gentlemen, these men are not infallible. They make mistakes, and I do not doubt but what if you put some of them in a pan and put some water in and stirred it around the water would be roily (laughter), but if you kept applying water long enough you would not find traces of gold, but you would find gold nuggets in the bottom of it (applause). Now, don't criticise this bunch. They will do things wrong. If they didn't they would be in heaven, and we don't want them in heaven. We want them here (laughter), to advance the interests of wood preservation, and if they do things you don't like, remember the pan. Let it go over and down the creek, and you will get the gold, the real gold, and there is nothing in this country that will produce more gold for this great country of ours than conserving our forests, and there is no way you can conserve our forests better than by preserving wood. [*Applause.*]

THE PRESIDENT: Mr. Joyce, I would like you to come up here because I wish you to receive a compliment from the Association. You all seem to be happy over the results of the Service Bureau Board, and I wish you all to look in the face of the man who worked harder to produce this Service Bureau Board than any other in the Association (applause). By the way, he left Florida and came all the way up here to be present at this time. This Service Bureau Board is something he is proud of and so ought to tell you about it.

MR. JOYCE: Mr. President and Gentlemen: We have heard a lot about gold. Occasionally there is in nature something very rare that produces pure gold, gold that contains no dross. It is not necessary to compliment nature. Gentlemen, we have with us the exponent of pure gold, Mr. Waterman. [*Laughter.*]

THE PRESIDENT: Any other comment at this time on the work of the Service Bureau Board? If you have no bouquets, give us something else. Mr. Crawford, I am sure I speak for the Association in saying that we are agreeably surprised at the results the Service Bureau Board have been able to accomplish in these short six months. I know that a year from now the Association will not be only stronger on account of you, but it will be boosting more for you than they are doing today. We thank you for your report, and bid you Godspeed for another year. [*Applause.*]

Mr. Manley will now instill a little more confidence into our good industry. [*Applause.*]

CONFIDENCE IN THE INDUSTRY

By R. S. Manley

The subject assigned to me for a short address is "Confidence in the Industry." That is, in other words, a firm trust, or a firm belief in the industry.

Confidence in the industry may be either the confidence of those engaged in the industry, or the confidence of those outside of the industry in the industry.

It is my conviction that unless those within the industry have a firm trust, and belief in the industry, there is no chance for those outside of the industry to have such firm belief or trust.

There are a number of ways by which those within the industry may demonstrate their confidence, among which are the following:

1. By taking every opportunity to impress the dignity, usefulness, need, and efficiency of wood preservation on all persons with whom one comes in contact.
2. By endeavoring in every way to so operate a wood preserving plant, or to so conduct a business as to impress the outsider with the seriousness and honorable intent.
3. By urging customers to purchase that which will best serve their needs.
4. By taking active and serious part in the conduct of the affairs of the Association.
5. By supporting that very valuable mouth-piece of the American Wood-Preservers' Association, the Service Bureau.
6. By boosting not knocking.

I will take each one of these in turn and elaborate on it.

1. Every member of the Association should grasp every opportunity to speak, write, demonstrate, or in any other way spread the knowledge of wood preservation. This is the age of propaganda, an idea widely disseminated lives through successive generations. This country, and in fact the world has in the past been flooded with the idea that it is necessary to build of concrete or steel, if one wishes to build for permanence.

Bridges, barges, water tanks, culverts, transmission lines, and wharves have been built of one or the other, when preserved wood, in the end, would have served much better, and no account has been taken in many cases of the cost incident of upkeep to steel structures and steel barges in scraping, red leading, painting, dry docking, etc., and too little attention has been given the question of obsolescence which might result from rapidly changing traffic, and other conditions nor on the other hand to the reclamation value of preserved material when changes in structures are necessary. What other material can be re-used to the same extent as preserved wood? Study these points, and work hard to discover other points, and then talk until your tongue hangs out, and write until you have writer's cramp, and demonstrate as long as you can find anyone to demonstrate to; get worked up about it, and start the ideas circulating until they become as common as household words.

2. This relates to the conducting of a business, or the operating of a plant so as to inspire confidence. You should make sure that the Operating and Sales Department realize the ideals for which you are striving, to the end that by their efforts the public will expect and get material which will reflect credit on the industry, and inspire confidence in it.

3. This refers to the sale of material which most nearly fits the need of a customer. Customers naturally expect that wood preservers can tell them what will best serve them in the various types of structure, and in the various localities where they are to be used. While one cannot dictate to a customer as to what he shall and shall not buy, careful thought should be given to this question, and careful recommendations made which will impress the customer with the willingness and desire of the wood preservers to assist him, in showing him what will be to his advantage to use. Uniformity of recommendation can only be brought through standards.

4. As to active participation in the affairs of the Association, it is axiomatic that if one is a member he should shoulder the duties of a member. There are many outstanding examples among the members of the Association who have labored year in and year out in the interest of the Association, and to these men is due the credit for the present successful and prosperous condition of the Association. There are others, who for one reason or another, and I do not exclude myself from this class, have not been able to take, or who have not taken, as active, or as important a part in the upbuilding of the Association as they should, or could have taken. If there are any persons who feel that they are in this class, let them each go back to his work from this Convention with the firm resolution to do his best in every way to further the ends of the Association, and to undertake any work which may be assigned to him, or which he may feel capable of doing for the good of the Association.

5. *Support of the Service Bureau.* All that has been said before about publicity is made easier because of the existence of

the Service Bureau, and this Bureau deserves the whole-hearted support of the members to a greater degree than it has received up to the present time. Let me read to you a paraphrase of an article describing the Portland Cement Association, which to my mind exactly describes the Service Bureau:

> The Service Bureau of the American Wood Preservers' Association may be termed a "Scientific-Educational-Promotion Bureau" which is concerned in the increased knowledge, usefulness and use of preserved wood products and is not concerned in the commercial or competitive field, having nothing whatever to do with the sale or distribution of preserved wood, nor in the trading relationships between the members themselves or between the members and their patrons.
>
> Among structural materials, preserved wood products occupy a broad, unlimited and varied field of usefulness because of their resistance to all forms of wood destroying elements and because of their fitness and simplicity of use.
>
> Because of these facts the Service Bureau of the American Wood Preservers' Association, composed of firms interested in the wood preserving industry, was formed, its object being to enlighten the public at large and thereby increase the demand for preserved wood.
>
> There are quite a number of products which could be of great value and benefit to the consuming public, which have not received the attention and use that they are entitled to because of the failure of those distributing them to disseminate information as to their worth and usefulness. These facts have caused producers, in these modern times of advertising, to combine their forces in order to spread information concerning the qualities of their products, and wherever the consumer has found the products thus advertised, to be just what they are reputed to be, an increased demand results which is of great value to both the consumer and the producer.
>
> The result obtained by the Service Bureau, within the short space of time that it has been in existence, proves beyond a doubt that unified effort in the research-educational-promotion field will result in trade expansion without eliminating competition, so necessary to the welfare of the public. Through the efforts of this Bureau, within a short period of time, the consuming public will have a wide knowledge of the usefulness and qualities of preserved wood, which is of inestimable value in the forward march and progress of these times.
>
> Accomplishments in the field of decay prevention alone would warrant the work of this Bureau. If consideration is given to the annual loss sustained in this country because of decay in every form of unpreserved wood construction, it will be seen that enormous waste results, which places a great burden on the public and is depleting our once prized and large forests.

> Modern wharves, bridges, railroads, bulkheads, etc., are built of preserved wood because it is durable, sanitary, and the first cost is practically the last.
>
> There are plants connected with the industry located in all parts of the United States which not only afford work for many, but do a great service to mankind by transforming a product of limited life into one of unlimited life.
>
> This Bureau is cognizant of its responsibility to the public and for this reason it is doing its utmost to prevent the improper use and abuse of preserved wood and is using its best efforts to have it adopted wherever practicable. With the statistics it has accumulated, and through its research work, it is able to disseminate information that will show, when, where and how preserved wood will best serve the public, and the most trustworthy engineers, architects and contractors will accept its recommendations as final; and the interests of the private owners, municipalities and taxpapers will be well taken care of through these professions.
>
> Preserved wood ranks high in the development of modern highways as it is well adapted for use in permanent and adequate drainage structures that will take care of the present day and future traffic needs; and the work of this Bureau, in enlightening the public along these lines, is a great service rendered not only to the community but to the industry.
>
> Mankind of the present day has not come to realize and appreciate, to any great extent, the important position that Preserved Wood holds in the construction world, although its use covers a large field.
>
> Briefly speaking, the object of the Service Bureau is to distribute far and wide, advertising and literature that will extend the use of preserved wood and show how the best possible results may be obtained through its adoption.
>
> It is through the principles and practices adhered to in the conduct of this Bureau's work that its members express: (1) recognition of their responsibility to the public; (2) faith in the utility of their product; and (3) belief in the value and necessity of Research-Educational-Promotional work as a developer of their markets.

6. This refers to boosting instead of "knocking." I will pass lightly over this question of knocking, as it is so universally condemned not only as productive of lack of confidence, but also as the poorest of business policies, and because the tendency of the majority of wood preservers is to avoid the practice; however, I must refer to the resultant destruction of confidence, point out its probable cause, and prescribe the cure.

As all of you well know, wood preserving plants are built because of the hope and intention that they will be money makers. The belief that there is probability of large returns on the investment has caused the building of a larger number of wood preserving plants than the undeveloped demand for preserved wood justifies. Please note that I say *undeveloped.* The building plants, the capacity of which exceeds the demand for the product inevitably makes it difficult for all to fill their plants to capacity. Consequently the competition in securing the limited amount of business which offers, is very keen. Naturally all cannot be successful, and the effect of this limited and inadequate demand is bound to be disappointment and dissatisfaction. Faith in the industry is lost, and there are some who fail to appreciate the truth of the quotation:

"For every evil under the sun,
There is a remedy, or there is none,
If there is one, seek and find it,
If not, submit, and never mind it."

What is the remedy?

There is no industry in these United States which looks forward to a brighter future than our industry. Science and economy demand the continued use in increased quantities of preserved wood. The day of the all-heart schedules is passing and the available supply of all-heart timbers is lessening. This industry converts to usefulness the vast quantities of otherwise inferior woods and even without proper development of demand the industry will grow.

But what of the industry if developed?

I feel safe in saying that all that is necessary to completely fill the capacities of the existing plants is to develop the domestic market. The Service Bureau is getting valuable general publicity. This in the past has been lacking.

If those engaged in the industry will follow up this general publicity with their own advertising and by this I do not mean little square announcement cards in the technical papers; spending money to the same extent as other industries do, they will eventually have the demand created which will enable them to operate full time, sell their product at cost plus a fair percentage including the advertising expense and remove the causes which bring about loss of faith which destroys both the confidence within and without.

It does not take a great deal of business sagacity to deduce the truism: Too many plants and lack of demand calls for either the discontinuance of some plants or the creation of larger markets.

There is the greatest amount of ignorance to be overcome, even among engineers. As an example, one of the engineers in a southern state, after receiving advertising literature for months, after listening many times to the presentation of the value of creosoting by a competent salesman, was persuaded to visit a creosoting plant. His remark after careful inspection was, "Why you really have something of value, here. I read your literature because of the pictures and I listened to you, because you are a good fellow, but until now I didn't believe you had anything worth while."

Publicity, education, demonstration, advertisement, increased demand, living prices, satisfied owners, confidence restored,—this is the logical sequence. I should consider that the industry has advanced a great step if every man in the Association would pledge himself to once a week during the coming year to take an engineer to inspect a creosoting plant, his own, if possible, but at any rate a plant. I have never seen it fail to produce results,—an engineer who has been shown the investment, the process, the machinery, the product and the results as shown by service tests and records,—is sold. He feels that he is part of the industry, that he has more information about this modern discovery than his brother engineers, and he works for us. Each one of you—try it—you will be advancing your own industry.

In closing I want to say that I have the utmost confidence in the industry, I believe that without exception every plant desires and intends to so operate as to make its product produce confidence in the industry.

Let us take the Indianapolis Creed written by Meredith Nicholson as our guide. Here it is:

> "From this city of homes, James Whitcomb Riley sent winging his songs of light and cheer to gladden the hearts of the Nation. The Riley Spirit is the Indianapolis Spirit of confidence and hope. This best of cities rests solidly on the enduring foundation of American liberty under law. By serving my city, I serve my country. Each day I will help not hinder; work, not shirk."

In order to drive home the fact that the remedy which I propose above is not mere theory gleaned from reading "Printers Ink," "Advertising and Selling," or other propaganda issued in the interest of the advertising fraternity I give you herewith some concrete facts—namely, the experience of the company of which I have the honor to be president.

The number of inquiries received by this company for the years 1919 to 1921 inclusive were as follows:

In 1919 the circularization of prospective customers began; number of inquiries 497.
In 1920 mailing list was increased and circularization carried on slowly; number of inquiries 1,110.
In 1921 increased circularization and intensive advertising; number of inquiries 1,525.

Now it was to be expected that 1920 would exceed 1919, due to the extremely favorable conditions of general business in 1920, but the increase by 50 per cent in 1921 inquiries over 1920, in face of a near financial panic and extreme business depression shows beyond any shadow of a doubt that the trade extension program, the intensive cultivation and development of various potential markets was directly responsible for turning what might have been a tout into a victorious campaign.

Gentlemen, if you will only take this lesson individually to heart, and will case aside the ancient prejudices of the wood preserver to the expenditure of money for advertising, and with the confidence in the Industry which it deserves, boldly do your part, you will come into your own.

THE PRESIDENT: There is a good, gold nugget. Take it home with you. Our publicity has not been what it should be, but we are slowly rising to the occasion. When Mr. Aishton comes in here and tells us that that is our fault we must believe it, because up to this time we had thought that we had been serving the railroads fairly well.

Are there any other remarks at this time in connection with general promotion work of our Association? If not, we will proceed with our program, and the next in order is a paper entitled, "Feasibility of Using Tropical Hard Woods for Railroad Ties in this Country" by Nelson C. Brown. [*Applause.*]

MR. BROWN: Mr. Chairman and Gentlemen, when I was asked to get up this paper, I found that a great deal has been attempted along the lines of introducing tropical ties, but very little exact knowledge is available. It has been my object to get together all of the threads of the information that were available and set them forth in this paper which I trust will be of at least passing interest.

THE FEASIBILITY OF INTRODUCING TROPICAL TIES IN THE UNITED STATES

By Nelson Courtland Brown

The question of our future tie supply in the United States has long been an important one and is growing more serious each year. A great deal has been written and said on the subject so that it is almost unnecessary to emphasize here that our American railways are concerned over their future tie supply and its cost. This problem will some day be acute and it must be solved in one or a combination of the following three ways:

1. By growing a sufficient tie supply in our native American forests by an improved system of forestry.
2. By making both our present and future native supplies last longer by preservative treatment and proper tie protective devices.

3. By the introduction of ties from foreign sources of supply.

A study of the world's timber supply and the interdependence of various nations upon each other for their wood supplies has demonstrated that the tropics are the only regions of large timber supply left and that comparatively little exact scientific knowledge is available regarding them. To what extent they play at the present time and are likely to play in the future is the province of this paper.

After a comparatively exhaustive study of all of the available material in our libraries and by questionnaires sent to Maintenance of Way Engineers and others of all American railroads who might shed any light whatsoever on the subject as well as individual letters addressed to those who may have had experience either in the tropics or in the use of tropical ties in this country, it is regretted that information of a positive and satisfactory nature is exceedingly sparse or unavailable.

Our more immediate neighbors, Canada and Mexico, surely are not dependable sources of tie timber of the right kinds to any material extent. It is generally conceded that Russia has today the most extensive forests and timber supply of any nation on the globe and as yet the extent of these resources has not been definitely determined. Russia has, however, been the main source of timber supply for the heavily populated sections of western and southern Europe and in all likelihood will continue to fulfill this function in the future so that it cannot be depended upon as a source of lumber or ties for this country. Unless more extensive treatment of ties is practiced in this country and a comprehensive system of forestry is decided upon to supply the necessary ties for the future, we will be looking to other sources, and the tropics seem to be the only source of supply still available for our 450 thousand miles or more of trackage. At the present time our knowledge of those tropical resources is exceedingly meagre.

From time to time reports of vast areas of many kinds of trees, both large and small and various stories, often colorful in their descriptions have appeared in our trade and popular journals. Too often the nature of these reports has depended upon the character of some promotion scheme and consequently the nature of the information supplied therein has not been altogether scientific and in accordance with the facts.

By the tropics we must consider not only those near-by such as the West Indies, Central America, and Northern South America, but also the Philippines, Africa, the Far East and the Pacific Islands included in the tropical zone. The nearby regions such as the West Indies, Central and South America are of course of greatest interest.

Sporadic attempts have been made from time to time to exploit these forests for the more valuable kinds of lumber such as rosewood, teak and mahogany and other forms of forest products as well as cross ties. With all of the many exploration trips, economic development, etc. of various sections of the tropics, it is surprising that more exact and correct scientific information is still sadly missing regarding the availability as well as the feasibility of depending upon the tropics for even a portion of our tie supply. It is a singular fact that there have been many inconsistencies surrounding this tie subject. For example, in the Brazilian tropics Eucalyptus trees from Australia have been introduced for a considerable mileage on a local railway in the Amazon district. Again Brazilian ties have been sent from the Amazon section to Italy for the National Railways there and it may be of further interest to know that the Siberian railway built across a country so richly endowed with forests is partially constructed of Douglas fir and redwood ties shipped from this country.

During the past 30 years or more, attempts have been made to introduce tropical ties to this country, especially from the West Indies and South America. Steamship lines have, in some cases, offered tonnage at a negligible cost or in some cases at no cost in order to get such a movement under way. It is obvious, of course, that such tropical woods of high durability, hardness, and weight such as mahogany, green heart, lignum vitae and quebracho would prove to be very excellent ties if their prohibitive cost for cross tie material would not prevent their further introduction.

It seems to be a notable fact that practically no satisfactory records have been kept of the use of tropical ties in this country in the past, with minor exceptions, thus throwing the tropical tie question still "in the air." Local, common, and scientific names are exceedingly confusing. The same woods are often called by different names in the Spanish, Portuguese, Indian and English languages even in the localities in which they are produced and they vary widely in the different sections of the tropics. The identification and classification of tropical ties is still an important factor and problem that must be solved. Green ties that should never have been tried and those that have been improperly seasoned or stored in vessels before being allowed to even surface season, have given many of these a bad name. In some cases ties of insufficient size have been used and in other cases some have been placed in the track when partially decayed.

Four important aspects of the situation must be carefully investigated before we can hope to throw much further light on the subject.

1. What ties are actually used in the railways of the tropical countries and how do they stand up under the wear and tear which they receive?
2. Are they available for export in sufficient quantities and is the cost of production, handling, and shipping to the United States within the bounds of competitive cost as against those produced here?
3. What effect does the change of temperature, moisture conditions, heavy and frequent rolling stock, have upon them?
4. To what extent do these ties lend themselves to preservative treatment and how will this influence the situation?

All of these questions should be answered with respect to each species. There are literally hundreds of them and no sweeping conclusions can be drawn of the feasibility of using tropical ties even with respect to those of a given country.

Ties have been brought here from Cuba, Columbia, Brazil, Argentine, Africa, as well as Venezuela. Generally speaking the atmosphere and soil conditions are much more severe as affecting the life and utility of ties in those countries than is true in this country. Moisture, warm air, etc. induces the growth of fungi which cause decay and in addition they commonly have white ants, etc. which are exceedingly destructive to these woods.

The experience of a number of railroads might be recited regarding tropical ties but they do not shed any conclusive light on the subject aside from the general statements as noted above. It may be of interest to know that about 25,000 ties were imported from the Amazon district of Brazil and placed in the trackage of about five eastern railways in the years 1915–16–17. One railway placed 5000 ties, including 15 to 20 different varieties of hard, heavy woods from Brazil. They were presumably well-seasoned when put into service and it is reported that all failed except one species locally known as Masaranadauba. During the past year all other varieties have been removed from the track. The failure was reported due to "brooming" and to some extent to decay. "Brooming" however, was the principal reason for failure and a small percentage of failure also applied to Masaranadauba during the same year. All of these ties were 7" x 9" x 8½". Various opinions have been given as to the cause of "brooming" which is not supposed to exist in the native habitat of the wood. Some state that the differences were due to changes in climatic conditions, that is, change from extreme heat to extreme cold combined with heavy traffic and loads, crushing the ties after they have been checked severely. Some engineers have stated that if properly seasoned they would work out much more favorably. Another species, Javaira, is reported to have done fairly well. Among the 5000 ties tried out by this railroad, many of the ties had to be removed during the second summer and during the fourth summer of service a large percentage had to be removed on account of failure due to severe checking and "brooming." All of these ties had been adzed and bored at a treating plant, but were used untreated.

It may be of further interest to know of the experience of railways in several tropical regions and of other sporadic attempts to use tropical ties in this country.

The Director of Forestry at Manila reports that the following woods last from 8 to 12 years untreated in the Philippines; that they require no tie plates and that the ordinary rail spike does not work loose in them. These woods are locally called molave, ipil, yacal, apilong, and guigo. The Philippine Railway Co. now accepts 35 different native woods for ties.

The Santa Fe R. R. has tried out 200,000 stringy bark and blue gum (encalyptus) ties from Tasmania. These were only 5" x 8" x 8' long and many of them failed to reach 5 inches in thickness. These ties did not stand up under the heavy service to which they were subjected on account of being insufficiently thick. The same railroad tried mangle prieto and chico sapote from Mexico but on account of the inexperience of the tie makers they did not prove satisfactory. The official of this railroad states that it is really unfair to give wide publicity to this failure and consequently a "black eye" to these woods when the probability is that it is not coming to them.

In British Guiana tests were made on 13 varieties of treated native woods and Baltic pine by a local railway. The native woods were all of hardwood measuring 4½" x 9" x 9' long, the ties were grooved ½ inch in depth to receive the rails and bored with ⅞-inch holes for nail spikes. After eight years all varieties except three were sound and in good condition. These three were Kautaballi, untreated Mora and treated Baltic pine which was badly decayed throughout. The latter wood is the one chiefly used by European railways and lasts about 25 years in England when treated. The tests showed:

1. The native woods after treatment were far superior to the treated Baltic pine.
2. Mora and wallaba *(Eperua falcata)* when treated resist decay under extremely adverse conditions of climate, precipitation and poor ballast.

Both mora and wallaba are abundantly available and can be produced fairly cheaply There are three varieties of mora of which the red more *(Dimorphandra mora)* is by far the best. When properly seasoned the red mora makes an excellent tie timber.

This experiment would also seem to bear out the contention that tropical ties should be used only in the treated condition. If this is so, it is unlikely that we shall look to the tropics to supply any considerable portion of our cross tie supply for a long time to come.

One large American railway carried on a test covering 30 varieties of tropical ties, chiefly of South America origin. Most of these failed in 7 years due to both splitting and decay. Some only lasted 2 to 5 years while a few such as mora, cacaque, roble pellin and quebraho remained for 10 to 12 years except the mora which varied in service from 4 to 12 years.

Another railway in the east used several thousand Brazilian ties in recent years. Of 2647 ties examined closely, 827 were removed from the track on account of splitting and "brooming" and decay after a service of 2½ to 3½ years. The Engineer of Tests states that many more will have to be removed after slightly longer service.

In Cuba, two of the railways report extensive experience with 25 different kinds of hardwood ties, all of which must be bored for spikes on account of their extreme hardness. Of these woods they report the following to be most satisfactory—in the order named—jiqui china, arabo, jucara negro, sabicu, caoba, quibra hacha, and Acaua. The length of service varied from 5 to 25 years, the average being about 11 years. All are used untreated. All ties are 6" thick, 8½' long with round edges. No tie plates are required and all ties are adzed. An extremely rigid inspection is necessary as many woods resemble each other and an expert in tropical woods sometimes will err in classifying them. At present practically all the available hardwood ties in Cuba come from the province of Camaquey.

The railways of Brazil, at first partially dependent on imported ties are now using almost entirely native woods. One company with about 2000 miles of railway uses 350,000 ties annually and accepts 47 different kinds of wood growing along their right of way. These last from 10 to 12 years untreated. They are all hewn from comparatively small trees. These cost the railway 60 cents apiece in 1918 delivered along the railway.

The railways of Southern Brazil (Parana, Santa Catharina and Rio Grande do Sul) use annually about 450,000 ties which are now cut from embuia, a common hardwood. These are said to last 15 to 20 years untreated and are much sought after by the railways of the State of Sao Paulo.

Many tropical countries, such as Brazil, Guatamala, Colombia, Venezuela and the Guianas are now using native ties whereas formerly they imported ties from Sweden, Canada, the United States and Australia. Lack of a knowledge of the local timber and its suitability for cross ties, labor difficulties or insufficiency, etc. were responsible for importing ties from temperate to tropical climates.

It must be remembered that the tropical countries contain thousands of trees, many of which, have as yet been unidentified or classified. Many different kinds of trees often grow on the same acre whereas only one or two or a few are found in the forests of the United States. Generally the trees are very knarled, crooked and unshapen. It is reported that the Amazon river flows for a distance of 1860 miles through a virgin forest occupying an area of 8 25,000 square miles, equivalent to over ¼ the size of the entire United States.

It is very apparent from the above that our store of knowledge on the subject is still exceedingly meagre, and the evidence at hand seems at times conflicting. It is suggested that prospective purchasers of tropical ties should first investigate the source, kind, seasoned condition, etc. of the ties which it is proposed to use.

This paper is only offered as a fragmentary progress report on the subject.

To sum up the situation:

1. No definite conclusions can be established regarding the feasibility of introducing tropical ties on account of lack of definite experimental tests on a sufficient scale.
2. Great confusion exists in nomenclature and classification.
3. Too little is known even in their native habitat of the relative merits, such as durability, etc. of these woods.
4. Very little is known of the seasoning qualities with particular reference to the effect of changes of climate and temperature on their usefulness.

THE PRESIDENT: This paper is now open for discussion.

MR. ANGIER: Mr. President, I think this paper of Mr. Brown's is very good, and I would like very much to see a committee appointed to investigate the matter further.

MR. FOLEY: Mr. Chairman, it may interest the members of this Association to learn that the American Railway Engineering Association has been requested by its Committee on Ties to assign to the latter the compilation of data regarding the service in the United States by ties of woods from other countries. This request is not based on any belief that the importation of ties is necessary to augment our domestic supply. The information obtained will supplement that regularly sought regarding ties of materials suggested as substitutes for wood. If the American Wood-Preservers' Association is convinced that ties must now or soon be imported, it must be convinced that the preservative treatment of the domestic production will not be undertaken or if it is that whatever treating may be done will not reduce our demands for ties to within the scope of our domestic supplies.

My understanding is that the foreign woods which seem to promise most as ties for use untreated in the United States are too valuable for other purposes, and their importation as ties is never likely to be profitable. From all I have been able to learn it seems that there grow in and near the tropics more trees which produce wood requiring preservative treatment for outdoor use than is the case in the United States. I believe that any interest the American Wood-Preservers' Association may have in foreign woods for use as ties lies in the Service Bureau seeking for its members the treatment of ties of foreign or domestic woods for use in foreign countries.

THE PRESIDENT: Are there any other remarks in connection with this subject?

MR. NELSON C. BROWN: Mr. President, apropos of Mr. Foley's remark, I agree with him in general, but I do not believe that a subject of this kind should be left to the time when it does become acute, because then we will go racing around for the information. It may take you two or three years to get it. Whereas, a few thousand ties from the tropics are imported each year into this country, it is very likely from the increasing cost and greater scarcity which certainly will exist in this country, that those tropics will be counted on to a greater extent. We ought to have more information some time about what ties must be treated before they can be brought to this country, and a great many other questions which I have suggested in the paper. I do not know whether the Association has the time to consider this subject just now, but it seems to me an important question, and it was just that thought that I wanted to leave with you.

THE PRESIDENT: The next paper will be by Mr. Jacobs, of Detroit, on "Lumber Drying by Vacuum."

MR. JACOBS (referring to a specimen of petrified wood): The bark on this is preserved to the extent that it looks almost like dried bark. One side has been polished, and you can count with the naked eye from sixty to seventy-five annual growth rings as it extends outward. This came from a place about 150 miles from Yellowstone National Park where it was dug up. In the same place there were trees 3 feet in diameter, and several of the limbs probably 4 inches in diameter, and 4 feet long. I happened to collect this particular specimen because it was easy to carry. There were larger ones along the same line.

LUMBER DRYING BY VACUUM

Oscar E. Jacobs

I appreciate the privilege of appearing before the American Wood-Preservers' Association to present a few facts about a new and quicker way of performing an old and troublesome necessity, namely, drying wood in the form of lumber, timbers, etc.

Thinking it might be of interest to your members I have brought here to show you one of the first pieces of wood that was treated with a preservative. Mr. Kearn, the geologist, who loaned the specimen, assures me this wood is one million years old. I don't know about the age but it shows no signs of decay and the annular growth rings of the tree are plainly shown, as you can see from an examination of this specimen of petrified wood. If its age as given is correct the drying of wood by artificial means is very modern compared with preservation. The statement has been made that the first attempt at drying wood by artificial means was conducted by King Solomon when he caused the cedars of Lebanon to be boiled in some solution, presumably oil, to hasten the drying and completion of his temple. We don't know about this either but we notice as recorded in second Chronicles that much oil was furnished to the hewers in the forests of Liberus.

We all know that wood in its growing state contains some portion of moisture and that most of this moisture must be removed before the wood can be used commercially. Nature's method is too slow to perform this function for us, and we must resort to artificial means. There are two problems that enter into drying wood—time and the removal of the moisture without damage to the wood. The wood must not be damaged by warping, splitting, checking, and various other reasons, and it must be dried quickly for economy.

I have carefully investigated much data and believe I am safe in stating that the progress that has been made in improving the present commercial practices of lumber drying during the past 100 years is negligible. During the past 25 to 40 years the so-called methods of drying lumber as used commercially have all been similar in operation, the detail depending largely on the individual ideas. The principle employed, however, was the same—drying wood from the surface. We know that millions of feet of lumber are lost or damaged annually in drying, and undoubtedly most of this is caused by uneven drying thus setting up unequal shrinkage and stresses. Wood swells or shrinks according to its moisture content, and by methods in practice the evaporation of the moisture must be slow and even to allow the outer fiber to absorb from the inner fiber, or too much shrinkage of the outer surface causes deleterious effects, such as checking, warping, case-hardening, and honeycombing. The practice in vogue is applying heat to the surface of the wood and allowing it slowly to penetrate to the center. It is obvious that a faster evaporation is set up immediately at the surface until the heat has reached the center, but as no means is provided for carrying off the center moisture it is slowly taken out by absorption from fiber to fiber until it reaches the surface. In thick pieces of wood, especially, it is necessary to apply an additional moisture to the outside surface to prevent too fast shrinkage of the surface while the center is still in a wet state. Along with the above there must be some method for carrying away the evaporated moisture. It is generally by natural or forced drafts. The entire procedure can be compared to Jack and Jill pushing a heavy ball up an incline. Jack pushing up with 100 per cent of his energy and Jill pushing down to an extent of 95 per cent of Jack's energy.

We shall attempt to show you how we have persuaded Jill to push up hill with 95 per cent as much energy as Jack and thus apply 195 per cent of energy to moving the ball up hill as compared with 5 per cent as before attained. The removal of moisture from wood must be done by evaporation, and this can best be accomplished under vacuum.

The use of vacuum is little understood by the average engineer. More development has been made in the uses of vacuum during the past three years than had been developed in twenty years previously. This probably is due to the development of a new type of pump which operates cheaply and gives almost a perfect vacuum or within ½ to 3/16 inch of the barometer. Some attacks have been made on the so called "mysteries of vacuum drying." I have studied the subject for the past ten years and have found no mysteries; but I have endeavored to apply its principles in a common-sense manner to lumber drying, and I have successfully dried lumber green from the saw, ⅝-inch thick gum in 8 hours up to 4"x5" maple in 96 hours. Vacuum is only the absence of atmospheric pressure in some degree, and to the extent of the absence of this pressure water boils or evaporates to its maximum with a lesser degree of heat. As it is necessary to supply heat to the wood in its wet state in order to evaporate the moisture the quickest way of heating the wood is under steam pressure, as the heat will penetrate the wood in minutes where it requires hours under atmospheric heating. Under steam pressure the wood is also heated throughout without setting up surface evaporation.

Reed, Wagner and other authorities tell us that wood can be heated to 240° F. without damage, and our observation leads us to believe that this temperature should not be maintained for any great length of time. This heat of course—a live steam only. We find that under 20 pounds of steam pressure or 240° F. inch lumber can be thoroughly heated in 15 to 20 minutes to the above temperature, and thicker lumber in a proportionately longer time.

It is possible that enough heat units are supplied to evaporate the moisture if none were wasted, as we reduce the boiling point by vacuum, but we find that steam coils in the retort will supply any deficiency. Water boils at 212° F. at atmospheric pressure, at 100° under a 28-inch vacuum, and at 75° with a 29-inch vacuum. Some method is necessary to carry away the moisture as it evaporates from the wood, and this means is supplied by constant running of the vacuum pumps which draws the vapor from the retort as fast as it appears.

The moisture in the center of the wood is the part that is the most difficult to remove by the old practice, so we give this attention first. By heating under steam pressure the wood is brought to a temperature approximately 240° F. without setting up surface drying. Immediately our heating period is over we drop the surface temperature to 212° by blowing off steam, and we further drop these temperatures by the use of vacuum to a point of 75° to 100° F.

Other things being equal, wood cools as slowly as it heats. We therefore set up a condition where we have a higher temperature in the center of the wood than at the surface. This causes a pressure of vapor from the center outward through the pores of wood. As the higher temperature vapors push out over the cooler surfaces assisted by the pull of the vacuum, this vapor has a tendency to slightly condense which keeps the outside surface or all portions of the wood at an even degree of moisture through the drying period, which gives even shrinkage and no deleterious effects. If we do not dry from the inside out we dry the wood equally throughout, as has been shown by test borings from various locations of a cross section. Because of drying under vacuum we have all elements always under control, and we have the temperature at or above boiling point, and secure the result of quick evaporation just as subjecting a gallon of water at 100° under a vacuum pump pulling a 28-inch vacuum. The water would vaporize in a few minutes but if the same water were standing in the atmosphere at 100° F. it would require weeks to vaporize.

The present practice of drying lumber starts with a low temperature, slowly heats the wood, and still more slowly evaporates the moisture from the surface as it is absorbed from the center fiber to fiber.

The vacuum process reverses this order. The wood is first subjected to the highest temperature and quickly heated throughout. We then drop our surface temperature and obtain the result of the heat pushing the moisture from the center outward and by the pull of the vacuum pump we are constantly removing the vapor through the pores of the wood from the inside outward or drying the wood inside out. We obtain quick evaporation instead of slow to the extent of drying the wood in 1/15 to 1/20 of the usual time of kiln drying without the months of air drying, and we are able to take green lumber from the saw and thoroughly dry one-inch lumber and have it in perfect condition in 24 hours. I appreciate that to the ones experienced in the art of lumber drying as now used in commercial practice the above statement is unbelievable. But after several years of gathering data and evolving the theory, through the courtesy of the C. B. Q. R. R. extended by Mr. J. H. Waterman, the first tests were made at their experimental plant at Galesburg, Illinois. In concluding let me say that the first time I opened the retort and found I had perfect and dry lumber which had been put in green a few hours before, I believe I appreciated the feeling Christopher Columbus must have had when he first sighted the West Indies.

THE PRESIDENT: Mr. Jacobs' paper is now open for discussion.

MR. MEYER: As I was present when Mr. Jacobs made these experiments with gum, I am very interested to find out from Mr. Jacobs if he has used any other kind of wood and, if so, what his experience was with those other kinds of wood.

MR. JACOBS: Experiments have been made on gum, maple, birch, Douglas fir, and several other woods. I can't name all. There have been some eight or ten woods used in the experiments.

MR. MEYER: Did they all act alike?

MR. JACOBS: Practically so.

MR. HUNT: Mr. Chairman, those of you who have studied kiln drying no doubt appreciate that the method proposed by Mr. Jacobs is quite different from the method which has been advocated by the Forest Products Laboratory for a number of years. That does not mean that Mr. Jacobs is wrong, or that the Laboratory is wrong, but that to some extent their ideas do not exactly agree. I turned the paper over to our kiln-drying men, and asked for their comment. They made two or three comments which might be interesting.

One was that the sensible heat stored in timber by steaming is about one-sixth or one-seventh of the amount required to evaporate the water in green timber and bring it down to a dry condition. The other six-sevenths of the required heat you will have to supply from the outside, as you do in drying by any other process. That means from your steam coils.

Now in a vacuum you have very little conduction or convection, because conduction and convection of heat through space depend on air currents, and on the presence of air. You get radiation, of course, from your cylinder. If you have one piece of wood in the center of a large heavy cylinder you will get considerable heat radiated to it. If you have a full charge of cross-ties in a cylinder you are not going to get a great deal of heat added to that charge by your coils. The question goes beyond that and there is a difference of opinion about it. It is a thing which time alone will decide, and if Mr. Jacobs' method proves on continued application on a commercial scale to be successful and economical, then he has done something for which the wood-using industries can heartily thank him. If it does not, it is like other things which each of us are promoting all the time, our new ideas. Some of them are good and some of them are not. So I should like to see this Association continue to watch these different methods of drying wood, and see what the result is.

THE PRESIDENT: We will now take up a subject that has been developing slowly. It is a subject that promises a much wider development in the near future; that is the problem of the treatment of mine props or mine timbers in general. We have three papers that deal directly with that problem, one by Mr. Hornor, of the United States Bureau of Mines, another by our Secretary, and another by Mr. Humphrey, and so the problem for the next few minutes will be Mine Timber Preservation.

MR. HUNT: Mr. Chairman, the papers by Mr. Hornor and myself have been printed, and distributed, and have been in your hands for some time. I don't propose to read either one of them, but I would like to make an explanation. Fifteen years ago or more the Forest Service, and I have no doubt some other people too, tried to interest the mines in timber preservation. They went to the extent of building plants at certain mines, demonstrating methods of treatment, both pressure and non-pressure, and putting in experimental timber. Since that time we have been watching the service given by these timbers and keeping records as adequately as possible.

The mines which started treating in those days are almost all operating their plants still, but the unfortunate thing is that very few, if any, additional mines have started to use treated timber. Why is it? It is because they have not been convinced of the value of it. Perhaps they never heard of wood preservation. It is because the Forest Service and this Association and all others interested in wood preservation have not given the attention to the mining industry that it deserves. It uses an enormous quantity of timber, as you will see by reading the statistics Mr. Hornor presents. Not all of that timber can be economically treated, but even if a small percentage can be treated the total saving will be so great that it will be a material saving to the country and a material saving to the mine operators.

What the Forest Service and the Bureau of Mines are now trying to do in cooperating in this work is to bring the message to the mining companies. We don't want them to put in experimental timber. We have long passed that stage. We want them to take the facts which are available, and decide which treatment and which preservative they are going to use, and then use it. If any of you attempt to do missionary work on this problem don't suggest that they put in experimental timbers. They will wait ten years for the results, and they will lose ten years. Get them to thinking about which method, and which preservative they want to use, and get them to act on it now. That is going to be our problem next year. We want the help of the whole Association. The reason we want the help of the Association is this: We can go and talk to a man and tell him things, and he may believe them, but he does not take action, but if salesmen go to him and tell him about the value of zinc chloride or some other preservative for preserving mine timbers, they don't quit until they make the sale, and when they make the sale he is going to use what he buys. That is why we want the wood-preservers, especially the commercial plants, to sell treated timber to the mining companies, and we want the makers of preservatives to get busy and work on the miners. The data here presented are for the use of any one who can get the contact with the mining industry.

WHY PRESERVE MINE TIMBERS?

By Geo. M. Hunt
In Charge Section of Wood Preservation
Forest Products Laboratory

The members of this Association, who are so familiar with the advantages of preservative treatments are no doubt more inclined to ask "Why not preserve mine timbers?" than "Why preserve them?" The mine operators as a rule are still unfamiliar with wood preservation, however, and must be shown. An example of the state of mind of some mine operators with regard to the possibility of increasing the life of their timbers was shown in the advertisement of the Anthracite General Policies Committee in the New York Times of October 3, 1921, and in other papers, in which the impression is given that it is impossible to reduce the consumption of timber in anthracite mines.

Most mining engineers and operators have been so fully occupied with other problems connected with their work that they have apparently given little thought to increasing the life of their timber. It is high time that this situation should be remedied and that the miners who are not using treated timber should be shown the opportunity they are overlooking. To this end the Forest Products Laboratory and the U. S. Bureau of Mines are making cooperative effort, and the assistance of every member of this association is needed. The information in this paper is presented in the hope that it may prove useful in further promoting mine timber preservation.

Service Records.

Service records of mine timbers are not easy to obtain. It very frequently happens that after treated timber has been in use for a number of years, but before its limit of life has been obtained, the part of the mine in which it is located is closed for some reason and further inspections can not be made. Crushing and breakage by movement of the rock, and damage to the timbers in other ways or destruction of their identifying marks also prematurely remove many of them from the test. For these reasons mine timber service records are not nearly so extensive as post, pole, and tie records. The Forest Service however has, to the best of its ability, been keeping records for about fifteen years on mine timbers in cooperation with mining companies in various parts of the country. The results to date which can readily be tabulated are shown in table 1.

An examination of this table shows the marked superiority of treated timber, although the records as a rule do not permit an exact comparison of the relative life of treated and untreated timber. The greatest percentage increase in life is shown of course in the mines, such as the D. L. & W., where the untreated timber has such a very short life, but even in mines where the untreated timber lasts for a relatively long time the treatment has resulted in increased durability.

A rather extensive experiment was started during the years 1906 to 1908 at the mines of the Philadelphia and Reading Coal and Iron Company near Pottsville, Pennsylvania. Timbers treated with zinc chloride, creosote and other preservatives, using various processes, were placed in service, in comparison with untreated timbers of similar quality. The treatments were made for the most part on sap pine timbers. The great majority of these timbers were lost from the experiment, owing to closing of gangways, crushing, and other causes not preventable by treatment, and it is impossible to form a close estimate of the increase in life afforded by the more thorough treatments. Some very good comparisons were secured during the early years of the experiment, however.

All of the untreated material, including loblolly, shortleaf, and longleaf pine, Pennsylvania pitch pine, and black oak failed within 1 to 3 years. The average life was close to 2 years.

Brush treated timber lasted 3 to 4 years.

About 13 per cent of the green timber open tank treated with zinc chloride showed marked decay after 4 years service, while no decay was found in 4 years in similarly treated timber seasoned before treatment.

No decay was found in 4 years in material open tank treated with coal tar creosote or water gas tar creosote.

It is to be regretted that service data on ties and timbers under mine conditions are not available in greater detail, and on a more comprehensive scale. The incomplete data that are available however indicate that preservatives properly applied will prevent decay under ground as well as above ground. They also show that superficial treatments do not give as much protection as thorough treatments. There is nothing in the available data to indicate that the principles which have been found true in preserving wood above ground do not hold true for underground work. In considering the probable effectiveness of various protective measures for mine timbers, therefore, we may safely draw upon the wealth of service data on timber used above ground.

Table 1.--Durability data on mine ties and mine timbers

Operating company	Location of experiment	Character of specimens	Species	Number included in test	Preservative used	Treatment	Results of last inspection: Date made	Results of last inspection: Years' service	Results of last inspection: Per cent still in service*	Results of last inspection: Per cent badly decayed or removed for decay	Remarks
Tennessee Coal, Iron and Railroad Company	Birmingham, Alabama	Mine ties	White and post oak	50	None	Untreated	1920	10-1/2	74	26	
" "	"	" "	Shortleaf and loblolly pine	50	None	"	1915	5	32	68	Only 2% sound. Heading closed preventing further inspections.
" "	"	" "	" "	50	Coal tar creosote 8# cu. ft.	Pressure	1920	10-1/2	100	--	
" "	"	" "	" "	361	Cresol calcium 0.9# cu. ft.	Low pressure	1920	10-1/2	59	41	
" "	"	10" x 10" mine timbers	Heart pine	30	None	Untreated	1919	9-1/2	--	100	Average life 9.4 years
" "	"	" "	Shortleaf pine	186	Coal tar creosote 6½ to 9½ lbs. per cu. ft.	Pressure	1919	9-1/2	99	1	Gangway closed in 1919. Further inspections impossible.
" "	"	Mine ties	Loblolly pine	94	None	Untreated	1920	6	87	13	
" "	"	" "	" "	137	Zinc chloride .25 to .63# cu.ft.	Pressure	1920	6	100	--	
" "	"	" "	" "	139	Sodium fluoride .23 to .73# cu.ft.	"	1920	6	100	--	
" "	"	" "	" "	135	Mixed zinc chloride & sodium fluoride .26 to .82# cu.ft.	"	1920	6	100	--	
" "	"	" "	" "	50	Coal tar creosote 10 lbs. per cu.ft.	"	1920	6	100	--	
Delaware Lackawanna and Western R. R. Company	Scranton, Pennsylvania	Mine timbers	Hemlock and loblolly pine	13	Carbolineum	Hot and cold bath	1915	6-1/2	92	8	Gangways flooded. No inspections since.
" " "	"	" "	" " "	13	Coal tar creosote	" " "	1915	6-1/2	100	--	" " " "
" " "	"	" "	" " "	34	" " "	" " "	1921	13	85	15	When these timbers were set, the average life of untreated timber in this mine was reported as about two years.
" " "	"	" "	Pine, hemlock, beech, maple	13	Carbolineum	" " "	1921	13	85	15	
Bunker Hill & Sullivan Mining & Concentrating Co.	Kellogg, Idaho.	" "	Idaho white pine	14	Marschall salts 1.1# cu. ft.	" " "	1921	11	93	7	Ave. life of untreated timber in this mine was reported in 1910 as about six years.
Hercules Mining Company	Burke, Idaho	" "	Douglas fir	Large number	Creosote	Low pressure	1921	7	100	--	These timbers are all sound.
" " "	" "	" "	" "	" "	None	Untreated	1921	7	See note		These timbers not removed but all badly decayed.
Anaconda Copper Mining Company	Butte, Montana	" "	" "	87	Creosote Absorption 2.66 lbs. cu.ft.	Pressure	1919	8	77	23	
" " " "	"	" "	" "	99	Creosote	"	1919	8	96	4	
" " " "	"	Shaft timbers	" "	282000 bd.ft	Creosote, 3.64 lbs. per cu. ft.	"	1916	5	100	--	Conditions favorable to decay. Timbers later gunited and further inspection impracticable.

*Includes those marked sound and partly decayed but excludes those marked badly decayed.

When Treatment is an Economy.

Even though the life of timber can be increased by treatment it is not usually a paying proposition to the operator unless the treatment reduces maintenance charges. There are certain other advantages to be gained by treatment, but they are less important in the eyes of the operator and they do not receive the same consideration as maintenance costs.

The relative cost of maintaining treated timbers as compared with untreated timbers will depend upon the relative durability of the two, and their first cost in place. If untreated timber is giving a very short life it is easy for treated timber to show great savings. Where the untreated timber gives long life the savings due to treatment will not be so great. Considerable quantities of timber are used in mines where a life of only a year or two is desired, after which that part of the mine is abandoned. Under such conditions treatment might be a waste of money.

Use of Tables.

By means of the data in table 2 it is a comparatively simple matter to determine whether or not treatment will be an economy. As a specific example let us take the 14th record in table 1, which shows that of 34 creosoted timbers in the D. L. & W. mines 85 per cent are still in service after 13 years. What the average life of these timbers will prove to be remains to be seen, but for our present purpose we will assume it to be 15 years. Untreated timbers at this mine were giving an average life of about two years when this experiment was started. At that time the average cost of an untreated set in place in the mine was estimated at $5.98, and of a creosoted set $7.41. The cost of treatment was therefore about $1.43 per set, which added about 24 per cent to the cost of the untreated wood.

Assuming an interest rate of 6 per cent, which seems high enough for the time when these tests were started, and referring to table 2, it will be seen that the annual charges for a 2-year life are $0.545 per dollar invested, which makes a total annual charge on an untreated set $3.26. The annual charges for a 15-year life are shown in the table to be about $0.102 per dollar invested, or a total of $0.76 on the treated set. In other words, the cost of keeping a gangway timbered with untreated timber was $3.26 per set per year as compared with $0.76 per set per year for the treated timber. This shows a saving of $2.50 per set per year, in favor of the treated wood.

This calculation is made after the tests have been practically

Table 2. Annual charges due to an initial expenditure of one dollar.

Interest Rate	Term of Years																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	18	20	22	24	26	28	30
4%	1.04	0.530	0.362	0.275	0.225	0.191	0.166	0.148	0.132	0.123	0.114	0.106	0.100	0.094	0.086	0.079	0.073	0.069	0.065	0.062	0.060	0.058
5%	1.05	0.538	0.367	0.282	0.231	0.197	0.173	0.155	0.140	0.129	0.120	0.112	0.106	0.101	0.092	0.085	0.080	0.076	0.072	0.069	0.067	0.065
6%	1.06	0.545	0.374	0.288	0.237	0.203	0.179	0.161	0.148	0.135	0.126	0.119	0.112	0.107	0.098	0.092	0.087	0.083	0.079	0.076	0.074	0.070
7%	1.07	0.553	0.381	0.295	0.243	0.209	0.185	0.167	0.153	0.142	0.133	0.128	0.121	0.116	0.109	0.103	0.097	0.092	0.088	0.086	0.083	0.081
8%	1.08	0.561	0.388	0.302	0.250	0.216	0.192	0.174	0.160	0.149	0.140	0.133	0.127	0.121	0.113	0.107	0.102	0.098	0.095	0.093	0.090	0.089
9%	1.09	0.568	0.395	0.309	0.257	0.223	0.199	0.181	0.167	0.156	0.147	0.140	0.134	0.128	0.120	0.114	0.110	0.106	0.103	0.101	0.099	0.097
10%	1.10	0.576	0.402	0.315	0.263	0.227	0.205	0.187	0.173	0.162	0.153	0.146	0.140	0.135	0.128	0.121	0.117	0.114	0.110	0.109	0.106	0.105

[A] Based on the formula, $A = P \frac{(1+r)^n r}{(1+r)^n - 1}$, in which A = annual charge,
P = amount of initial investment,
n = number of years in the recurring period (the average life of the timber),
r = the rate of interest expressed decimally.

completed. Suppose it was desired to know 15 years ago whether treatment would pay. The mine operator, knowing the cost of treated and untreated timbers in place and the average life of his untreated timbers could estimate how long the treated timber would have to last to be as cheap as the untreated timber. In the case discussed above, the untreated timber cost $5.98 in place, the treated $7.41 and the untreated timber lasted 2 years. From the table as before, we learn that the annual cost of the untreated set is .545x$5.98=$3.26. Since the annual charge for the treated and the untreated timber is to be equal we can now set up the equation, $7.41 \times y = 5.98 \times .545$, or $y = \frac{3.26}{7.41} = .439$. Referring again to the table it is seen that an annual charge of $0.439 per dollar is equivalent to a life of somewhat less than 2½ years. In other words the mine operator could learn from this that if the treatment added only ½ year to the life of the timber it would pay for itself, and he could be sure from the experience of others that it would add much more than this, and therefore would be a paying proposition.

When the life of untreated timber is relatively long the savings due to treatment are not likely to be as great as indicated above. Records 5 and 6 (table 1), which pertain to timbers used under the same conditions in the same gangway might appear to be such a case. Here the untreated heart pine gave a life of 9.4 years. Records on the costs of these timbers indicate that the heart pine untreated cost about $16.50 per M feet delivered and the shortleaf and loblolly pine about $12.50 per M feet. Treatment of the sap pine cost about $4.70 per M feet and placement of both kinds of timber cost about $13.00 per M. Thus the untreated heart pine in place in the mine represented an outlay of about $29.50 per M, while the cost of the treated material was about $30.20, or practically the same. However, the untreated material was all replaced before the gangway was closed, at a cost certainly much greater than that of the original installation, while only 1 per cent of the treated material was replaced. The total outlay on the untreated timber was therefore over twice as great as on the treated timber and the treatment resulted in very material savings. This is an excellent example of the savings which treatment often makes possible by permitting the use of cheap low grade timber instead of higher priced material.

Other Advantages of Treating Mine Timbers.

There are several other advantages arising out of the use of treated timber which should not be overlooked, although they may not seem as important as cutting down maintenance costs.

The *fire hazard* in decaying timbers is much greater than in sound timbers. The merest spark coming in contact with the ragged surface of a decaying timber may start a serious fire, but on the solid surface of a sound stick it would have no effect. Mine fires are to be dreaded above all fires, and anything which tends in any way to reduce the fire danger in mines is worth while. Preservative treatment by keeping wood sound reduces the fire hazard.

The *strength* of timber is destroyed very rapidly by decay. Long before the wood has reached the crumbling condition which ultimately results from decay, it has lost most of its strength. This weakening extends considerably beyond the area where decay is apparent, and a stick which seems but partially decayed may have but little strength left. Undoubtedly much of the breakage of timber in mines is due to the fact that decay has first weakened the wood. Preservatives do not make wood stronger, but they enable it to maintain high strength over a long period of time.

Conservation of timber is of direct benefit to the timber user because it makes his timber supply last longer. Many mines draw their timber from their own lands or from nearby sources. If by adopting preservative treatment they can make one acre of timber supply them where it previously required several they are conserving their own resources as well as the Nation's timber supply.

Other benefits are that wood preservation makes it possible to reduce the number of timbering crews, reduces the danger of mine accidents, improves mine ventilation, and cuts down interference with mining operations due to timber failures.

GROWING NEED FOR PRESERVATION OF MINE TIMBER

R. R. Hornor

Mining Engineer, U. S. Bureau of Mines

A large field is offered by the mining industry for the introduction of treated timber. The business opportunities offered for the sale of wood preservatives, wood preserving equipment, and in some cases treated wood, should be of interest to the members of the American Wood Preservers' Association. I shall attempt at the same time to point out the needs of the mine operators, thus enabling the wood preservers to get in closer contact with the mining industry.

Large Quantity of Timber Used in Mines.

Unfortunately no exact data are available showing the quantity of timber used per annum by the mining industry in this country. Furthermore, no agency, either private or government, collects these statistics.

In 1905 the U. S. Forest Service,[1] in cooperation with the U. S. Geological Survey, collected from a large number of coal and metal mines in the United States, statistics on timber consumptions, which was the first systematic attempt in that direction. Although these statistics were by no means complete, yet a sufficient number of representative mines were covered upon which to base a fairly accurate estimate of the total timber used by the mining industry.

Following is a summary of the quantity of timber, both round and sawed, used in the production of various kinds of minerals in 1905:

	Cubic Feet
Bituminous coal	103,042,200
Anthracite coal	52,110,166
Precious metal ores	29,028,833
Iron ores	14,644,750
Miscellaneous ores	3,038,616
Total Cubic Feet	201,864,565

Of the total timber consumption 82.2 per cent was round timber and 17.8 per cent sawed timber. The percentage of the various kinds of timber was soft wood 30.3 per cent, hard wood 47.7 per cent, and not specified 21.9 per cent.

Since 1905 no systematic attempt has been made to collect mine timber statistics; however, a number of unofficial estimates, based upon the above-mentioned data, have appeared from time to time in the technical press showing the mine timber consumption in the coal and metal mines. Perhaps the most reliable of these estimates and the one most nearly approaching the truth was made by F. K. R. Moll in 1915 in an article entitled "Preservation of Timber in Mining."[1]

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[1] Forest Service Circular 49, U. S. Department of Agriculture.

Moll bases his estimate upon the production of coal, iron and other minerals for that year and the average amount of timber used per ton in their production. His figures show a timber consumption of 260,000,000 cubic feet, which is 28.8 per cent more than the consumption in 1905.

In the absence of any authentic mine timber statistics, and in order to show relatively the quantity of timber now being used annually by the mining industry, an estimate will be made based upon the mineral production for 1919 and the average quantity of timber used per ton of coal and ore mined. The figures representing the quantity of timber used per ton of the various minerals mined have been obtained from various sources and are thought to be fairly representative. However, it should be remembered that timber consumption varies greatly, depending upon the kind of mineral being mined, the nature of the deposits, methods of mining, etc., and may vary widely even in mines in the same locality producing the same kind of minerals.

The mineral production for 1919 is given in round figures in the preliminary reports of the U. S. Geological Survey as 458,000,000[1] tons bituminous coal, 88,000,000 tons of anthracite coal, 68,300,000 tons iron ore, and estimated approximately 65,500,000 tons of other ores. Of the 68,300,000 tons of iron ore, approximately 35,000,000 tons or 51.4 per cent was mined from underground workings requiring timber and the remainder from open pit in which little or no timber is used.

The average quantity of timber used per ton of mineral mined, taken from the most reliable sources available, are 0.33 cubic feet per ton for bituminous coal, 0.70 cubic feet for anthracite coal, 0.90 cubic feet for iron ore (underground mining) 0.75 cubic feet for other ores—gold, copper, lead, zinc, etc.

Based upon the above-mentioned figures of production and timber used per ton, the consumption of mine timber in 1919 is as follows:

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[1] Mining and Scientific Press, vol. 110, p. 68, 1915.

[1] All figures are in short tons of 2000 lbs.

	Tons (2000 lbs.)	Cu. ft. timber per ton		Total cu. ft.
Bituminous coal	458,000,000	x 0.33	=	151,140,000
Anthracite coal	88,000,000	x 0.70	=	61,600,000
Iron ore (shaft)	35,000,000	x 0.90	=	31,500,000
Other ores (est.)	65,500,000	x 0.75	=	49,125,000
Total				293,365,000 cu. ft.

This shows an increased timber consumption over 1905 of about 92,000,000 cubic feet or nearly 46 per cent.

Decrease in Supply and Quality of Timber.

One of the serious problems that now confronts the mine operator in the important coal and metal mining regions in both the East and West, is the noticeable decrease in the supply and quality of the timber in many mining regions, coupled with marked increase in cost.

In 1905, according to government statistics,[1] of the 43,676,000 cubic feet of round timber used in the anthracite mines, the hard woods rank first, with 14,238,000 cubic feet, or 32.6 per cent, of which more than 5,000,000 cubic feet was oak, the remainder being mixed hard wood—chestnut, beech, maple, etc. Of the 9,828,000 cubic feet, or 22.5 per cent of soft wood reported, 8,349,000 cubic feet was yellow pine, the remainder being hemlock and spruce in the order named. It should be stated, however, that of the various kinds and quantity of round timber reported nearly 20,000,000 cubic feet or 45 per cent was not specified.

Much of the yellow pine was shipped from the South, but most of the other timbers used were obtained in Pennsylvania. During the same period the average cost of round timber was 6.6 cents per cubic foot and sawed timber $15.17 per M. board feet. Assuming the consumption of 0.7 cubic feet, the cost per ton of coal was 4.6 cents.

At the present time perhaps 75 per cent or more of the timber used in the anthracite region is soft wood—loblolly and second growth yellow pine—most all of which is shipped from the South. No general cost of this timber is available, but figures obtained from one of the large operators show a cost approximately 27.5 cents per cubic foot delivered, of which 42.7 per cent represents the cost of the timber and 57.3 per cent the cost of freight. The cost of timber per ton of coal mined is 19.2 cents. It may thus be seen that during the period of 15 years from 1905 to 1920, the cost of round mine timber delivered in the anthracite region has increased from 6.6 to 27.5 cents, or more than four times.

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[1] Forest Service Circular 49.

No recent figures indicating the quantity and cost of timber used in the bituminous coal regions of the east and middle west are available, but it is reasonable to assume that the same relative increase will obtain as shown in the anthracite region.

In the Lake Superior iron region in 1905 the quantity of timber used in the mines was, in round figures, 13,152,000 cubic feet, of which 12,171,000 cubic feet was round timber and 981,000 cubic feet sawed timber. The bulk of the timber used was pine and hemlock, followed by comparatively small amounts of maple, birch and other hard woods. The average cost of round timber was 5.0 cents per cubic foot, and sawed timber $12.30 per M. board feet.

Based on the quantity of iron ore mined from underground workings in the Lake Superior region in 1920, and assuming a timber consumption of 0.9 cubic feet per ton of ore mined, the total timber consumption, in even figures, was 27,500,000 cubic feet. The predominant varieties now used are hard maple, yellow birch, hemlock and tamarack, in the order named, together with small amounts of ash, elm, pine and spruce. The average cost for all varieties ranging from 6 to 14 inches diameter, and in lengths from 8 to 16 feet, is approximately 24 cents a cubic foot delivered, or 21.6 cents per ton of ore mined.

It should be noted that the consumption of round timber in the Lake Superior iron mines has increased in the past 15 years from slightly more than 12,000,000 cubic feet in 1905 to 27,500,000 cubic feet in 1920, or two and a quarter times. During the same period the average cost rose from 5 cents to 24 cents a cubic foot, or nearly five times. Furthermore, the timber now available is much inferior in quality and less durable than the timber obtainable 15 years ago. This necessitates more frequent renewals, with greatly increased timber consumption and cost.

Throughout nearly all the metal mining districts of the west, the consumption and cost of mine timber has materially increased in the past decade. Likewise the more durable varieties of timber are bcoming scarcer and the source more remote from points of consumption, consequently in many localities the less durable varieties must now be used.

The timber most largely used in the metal mines of Montana and Idaho in 1905 was Rocky Mountain red fir (Douglas fir) with relatively small amounts of yellow pine, and lodge pole pine. Records show that the average cost of round timber at that time was 9.4 cents a cubic foot in Montana, and 10.3 cents a cubic foot in Idaho.

In proximity to the important mining centers of Butte, Montana, and of Coeur d'Alene, Idaho, the accessible supply of red fir is largely exhausted. As a result the more plentiful but less durable varieties—yellow and lodge pole pine, tamarack, with a subordinate amount of spruce and white fir (balsam)—are being extensively used. The present average cost of round timber, 10 to 14 inches diameter and 16 feet long, of mixed varieties in Butte is approximately 20.5 cents a cubic foot and in the Coeur d'Alenes 22 cents a cubic foot delivered.

It will be noted that the timber cost in two of the leading mining districts in Montana and Idaho was more than doubled in the past 15 years. No figures are available showing the increase in timber consumption, but no doubt it will closely correspond to the percentage increase as already shown for the other mining regions.

From the foregoing discussion of the mine timber consumption and cost in some of the principal mining districts in the United States, it is plainly obvious that one of the rapidly increasing items of expense in mining operations is the cost of timber, to say nothing of the labor cost of installation. Therefore, any practical means that may be employed to prolong the life of mine timber will greatly reduce mining costs, and effect important economies in operation.

Need of Timber Conservation.

The rapid depletion of our forests and the far reaching effect it may have on our industries as well as our national welfare has been repeatedly pointed out by those who have made an intimate study of the problem.

According to statistics published in the American Forestry[1] the consumption of timber for all purposes in the United States in 1919 was approximately 7.6 billion cubic feet, requiring in its production 23.6 billion cubic feet.

At the present rate of consumption it is estimated that three to four times as much timber is being consumed per annum in this country as is being produced by forest growth, and unless some measures are taken to arrest it the exhaustion of the better grades of structural timber may be expected in the no distant future. Moreover, the cost is mounting from year to year, as a result of the rapid depletion of the better grades. Naturally, the use of the better woods is being curtailed wherever possible, and the inferior and less durable woods substituted, which have only cheapness and availability to recommend them. The consumer, therefore, is confronted by the serious problem of having to effectively and cheaply prolong the life of the inferior woods and thus conserve the timber supply.

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[1] American Forestry, March, 1920, p. 146.

Mine timbers are destroyed by four principal agents—decay, insects, fire, and mechanical abrasion. Of these, decay and insect attack are by far the most important. The amount of mine timber destroyed by these different agencies varies greatly with the conditions in the mines, and depends largely upon the character of the deposit, and method employed in mining it. In general more than 50 per cent of the timber used in the mines is destroyed by decay and insect attack, but perhaps not to exceed 15 per cent of the total is subject to replacement, that is, where the working place will be kept open longer than the natural life of the timber.

Timber conservation may be accomplished in part by the better selection, preparation and storage of timber intended for mine consumption, but the most effective means is by treating the timber, to prevent decay, with some standard preservative before it is placed in the mine. It is needless to point out that only those timbers should be treated that will be used in working places which are to be maintained for a period of years sufficiently in excess of the natural life of the timber to warrant the use of treated timber. Neither should treated timber be used in places where it would be subjected to destruction by crushing rather than by decay.

Saving Resulting from the Use of Treated Mine Timber.

It is estimated that on an average possibly 85 per cent of all the timber employed annually in the mines in this country is used in working places of only temporary nature, such as rooms in coal mines and stopes in metal mines that will shortly be worked out and abandoned. Much of this timber is destroyed by crushing or covered up by waste rock and is of no further service. Even where subjected to decay its natural life is usually greater than its mechanical life, therefore preservative treatment would not be justified. The only practical means of reducing the quantity of timber used in this manner would be to either modify the existing system of mining or adopt an entirely different system, wherein less timber is required.

Of the enormous total of approximately 293,000,000 cubic feet of timber consumed annually in the mines it may be safely estimated that an average of 15 per cent or 43,950,000 cubic feet, is used in underground haulage ways, air ways, and other openings of a more or less permanent character where the timber is largely destroyed by decay. Experience has shown that the average life of mine timber in permanent openings, where it is not subject to crushing, is about 3 years, but often under conditions unusually favorable to decay the life will not exceed one year. Assuming that the average mine shaft, tunnel drift, and gangway, will be in service for a period of 12 years, it may be seen that the timber supports will be renewed at least three times, and under some conditions five to ten times. If the minimum figure is taken the quantity of timber consumed during the 12-year period is 175,800,000 cubic feet, of which 131,850,000 cubic feet might have been saved had the original timbers been given a preservative treatment. If the average cost of the timber be taken at 25 cents per cubic foot the saving in timber alone would be $32,962,500. The labor cost in replacing would be equal to and in many instances much more than the cost of the timber. It is obvious therefore that by treating timber to prolong its life the annual saving in cost of labor and timber will be large.

In the foregoing estimate of the annual consumption and value of mine timber no account was taken of the relatively large quantity of timber used in surface construction. Unfortunately, no data are available upon which to base even an approximate estimate of the quantity of timber thus used. Obviously, however, the quantity is large as may be appreciated by citing some of its many uses.

The principal surface structures built wholly or in part of wood are headframes, shaft houses, breakers, tipples, tramways, ore bins, coal bunkers, trestles, flumes, concentrating mills, stamp mills and mine buildings—comprising timber framing and carpenter shops, blacksmith shops, machine shops, power houses, change houses, supply houses, etc. In addition, an important amount of lumber and dimension timber is used in miscellaneous mine and mill equipment such as mine cars and trucks, tanks, launders, conduits, concentrating tables, jigs, flotation machines, classifiers, battery blocks, foundation timbers, etc. These structures and equipment require constant repairs and replacements, of which perhaps 80 per cent, or more, is caused by decay and could be largely avoided if the original timber were given a preservative treatment.

The average life of untreated wooden surface structures is placed at 10 to 12 years; however, the average life of timber entering into mine and mill equipment subjected to replacement from decay is probably not over 6 to 7 years. Assuming the average period of usefulness of all kinds of mine construction is 20 years, then the timber subjected to decay will require replacement at least once during its period of service, in the case of surface structures, and twice in case of mine and mill equipment.

With proper preservative treatment of the original timber entering into this construction, it could be made to last throughout the entire period of service, thus effecting an important saving in the cost of material and labor.

To determine the advisability and economy of treating underground timber, also timber used in surface structures and equipment Barth[1] formulated the rule which is substantially as follows: Timber that is permanent in character; that is, which is not exposed to destruction by mechanical wear or crushing before the expiration of its natural life or the usefulness of which does not cease before the advantages of chemical preservation can be realized, should be treated.

Extent to which Treated Timber is Used in the Mines.

In Europe, particularly Germany, treated timber has been extensively used in the mines for a great many years, and in 1915, according to Moll[2] no less than 100 large and small timber treating plants for mines had been erected. In 1904 there were in the mining district of Dortmund, Germany, 16 mines which treated timber and 25 others that had made trials. About 1903 a commercial timber treating company had entered the mining field and up to 1915 had erected over 30 plants in Silesia alone. However, in this country the mining industry has been slow to adopt the use of treated timber, notwithstanding that the replacement of timber caused by decay often constitutes one of the principal items of expense.

The explanation of this is that mining timber in most localities, until the last few years, has been plentiful and comparatively cheap. As a result no inducement was offered to practice economy in its use, furthermore, mine operators in general have not been well informed concerning preservatives, treatment methods and costs, and the benefits to be derived from the use of treated timber, but as they come more and more to realize these benefits its use, no doubt, will be rapidly extended.

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[1] Kurt C. Barth, Engineering and Mining Journal, vol. 104, 1917, p. 985.

[2] F. K. R. Moll, Mining and Scientific Press, vol. 110, 1915, p. 69.

In 1906 the Forest Service in cooperation with the Philadelphia and Reading Coal and Iron Co., undertook a series of experiments to test the practical value of treated mine timber, the efficiency of various preservatives, and the cheapest and most effective method of application for the purpose intended. Later, this service was extended to include other coal mining companies in the East and a few metal mining companies in the West. Although these experiments proved conclusively the practical value and economy resulting from the use of treated timber, yet the cooperating companies have not increased its use to the extent that was anticipated, and the quantity used by them at present as compared to their total requirements is insignificant. Neither has timber preservation been generally adopted by the mining industry to the extent that the results of the experimentation had given reason to hope.

The reason for the lack of interest in timber preservation at that time was that the timber situation throughout most of the mining regions of the country was not sufficiently acute to cause the operators to consider seriously the benefits to be derived from its adoption. In brief the introduction of timber preservation into the mining industry was premature, consequently it languished, for lack of support. However, in recent times with mounting cost of production, and the low price and lack of markets for the materials produced, the situation has entirely changed and mine operators are now ready to give serious consideration to any practical suggestion by which economies in operation may be effected.

Nelson[1] in a paper on wood preservation read before the Lake Superior Mining Institute some years ago aptly expressed the situation in the statement that the preservative treatment of wood must be recognized as distinctly a matter of dollars and cents. If it brings about a saving it will be adopted; if it costs more than it saves it will not be put into actual commercial practice.

Suggested Means of Promoting Timber Treatment.

It is believed that the artificial preservation of mine timber offers an attractive field in which important economies may be realized, and it is the opinion of the writer, based on his observations covering a field survey of some of the principal mining districts in Michigan, South Dakota, Montana and Idaho, that the time is opportune for promoting timber preservation in the mining industry. Just how this may be best accomplished is, of course, open to discussion, depending on the viewpoint.

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[1] Proceedings Lake Superior Mining Institute, vol. 14, 1909, p. 99.

One of the means that suggests itself is a campaign of education and publicity through the Service Bureau of your Association in cooperation with the U. S. Forest Service and the U. S. Bureau of Mines. The Forest Service has already carried on extensive experiments on wood preservation and conducted numerous service tests covering a period of many years. It has, therefore, much valuable data on the subject available for distribution, and is in a position to disseminate information on wood preservatives and preservative methods.

The Bureau of Mines has only recently undertaken a systematic investigation of the decay of mine timbers, and its causes and prevention. The Bureau's observations to date have led to the conclusion that not only important savings in the cost of operation may be realized by the use of treated timber, but also that preventing mine timber decay will remove one of the principal sources of heat and vitiation of mine air, which in turn has an important bearing on the problem of mine ventilation. The Bureau of Mines, therefore, is much interested and is glad to aid in promoting better utilization and preservation of mine timbers.

Mutual Interests of the Mine Operator and Wood Preserver.

The mine operator is interested in timber preservation because the preservative treatment of mine timber to prolong its life, will reduce operating costs, conserve the timber supply, and makes possible the utilization of inferior and less durable woods, which are practically useless unless treated to prevent rapid decay. In addition the use of treated timber to arrest decay promotes safety, health and efficiency of the men employed in the mines.

The wood preserver and the manufacturer of wood preservatives and wood preserving equipment are interested in mine timber preservation because it affords opportunities to expand the wood preserving industry and to promote the sale of equipment, preservatives and, in some cases, treated wood.

It remains for some practical plan to be initiated to bring about these desired results and if this paper by indicating the importance and need of timber preservation in the mining industry thus asissts in accomplishing this end it will have served its purpose.

MR. GOLTRA: I have been doing my mite to promote the use of treated material for coal mines, and in some instances, succeeded in convincing my listeners as to the economy effected by using treated material. I generally use the formula and table given in Mr. Hunt's paper, and which was discussed this forenoon. I usually recommend the "open tank" process because in most cases the material is obtained from localities in the vicinity of the mines, and it would not bear the cost of transportation to and from a plant equipped to treat same by the "pressure" process. Very good results have been obtained where the right kind of preservative was used.

THE PRESIDENT: The next paper will be by Mr. C. J. Humphrey, of the Forest Products Laboratory, on the "Decay of Timber in Mines." It will be illustrated.

MR. HUMPHREY: The entire purpose of this paper is to give you a general idea of the conditions to which timber is subjected in mines. I have not attempted to go into the wood preservation game or to indicate processes or anything of that sort. It is up to the individual operator to figure out what he wants and then to select and use one of the different methods that have proven fairly satisfactory in practice. The paper is necessarily rather general and at the end I will show you a few slides to give you an indication of the actual conditions which are encountered, and which will have to be overcome in the preservative treatment of timber in mines.

DECAY OF MINE TIMBER

By C. J. Humphrey
Pathologist, Bureau of Plant Industry
In cooperation with the Forest Products Laboratory

Up to about 1905 the study of the fungi found on mine timbers was mycological rather than pathological—dealing with the development of the organisms, rather than the nature of decay and the conditions favoring it. Much of the earlier work was done before the science of plant pathology had developed and consists of descriptions of the various plants found in mines, caves, and underground passages of various sorts. The scientific mind then concerned itself largely with the form and structure of the abnormal growths which were there met with and endeavored to correlate these aberrant forms with those normally growing above ground. Much less was known at that time regarding the variability of the different fungi encountered and it is not surprising that the peculiar growths, usually bearing little resemblance to the species as known under outside conditions, should have been given many different names, depending on the personal opinion of the man who described them. Many of the forms thus discussed are fantastically named. Thus, in Ulysses Aldrovandus' book on dendrology (tree botany), published in 1671, Braun tells us that two fungi are pictured which were taken from oak wood in a cellar. One of these is called "*Fungus gallipes*" and the other "*Fungus anguinus*." In Braun's opinion these are nothing else than abnormal forms of *Lentinus lepideus*, which from later investigations we now know to produce tremendously elongated, often "staghorn-like," growths in mines and other dark moist places.

The writer has during the past fifteen years been very much interested in the decay of mine timber and the fungi associated with it, and many workings in practically all the mining regions of the United States have been explored in order to throw light on the question.

In addition to discussions just presented by Mr. Hornor and Mr. Hunt, data on the consumption and cost of mine timbers with descriptions and discussion of wood-preserving methods have been published from time to time, principally by the U. S. Forest Service. These show distinctly the tremendous amount and value of wood used in underground workings and the necessity of conserving it by preservative treatments wherever the primary cause of failure is decay or insect attack.

The extent of timbering in mines depends largely on the character of the rock in which the operations are carried on. If it is hard and firm, tunnels are often run for considerable distances, with little or no timber. On the other hand, where the rock is soft, or where slippery clays are encountered, or where the weight of superincumbent rock is so great as to cause a gradual closure of the passages by pressure, it often taxes the skill and ingenuity of the engineer to keep the workings open. In such cases timber is used unsparingly.

Timber of all sizes finds a use, the larger sizes and more durable timber being used where great strength is required, or in the more permanent locations. The smaller sizes are frequently used in temporary locations, while limbs and slabs are used as "lagging," either laid across the collars to support the loose rock of the roof, or back of the legs to act as a retaining wall at the sides of the gallery. In addition, much small material and refuse is used for cribbing, many small ties for haulage ways, and much sawed lumber, mostly in the form of planks, for chutes, stopes, shafts, stations, etc.

Much more coniferous timber is used than hardwood, and this is very often of the lower grades, since for general purposes the mining industry can not compete with the lumber trade for the better

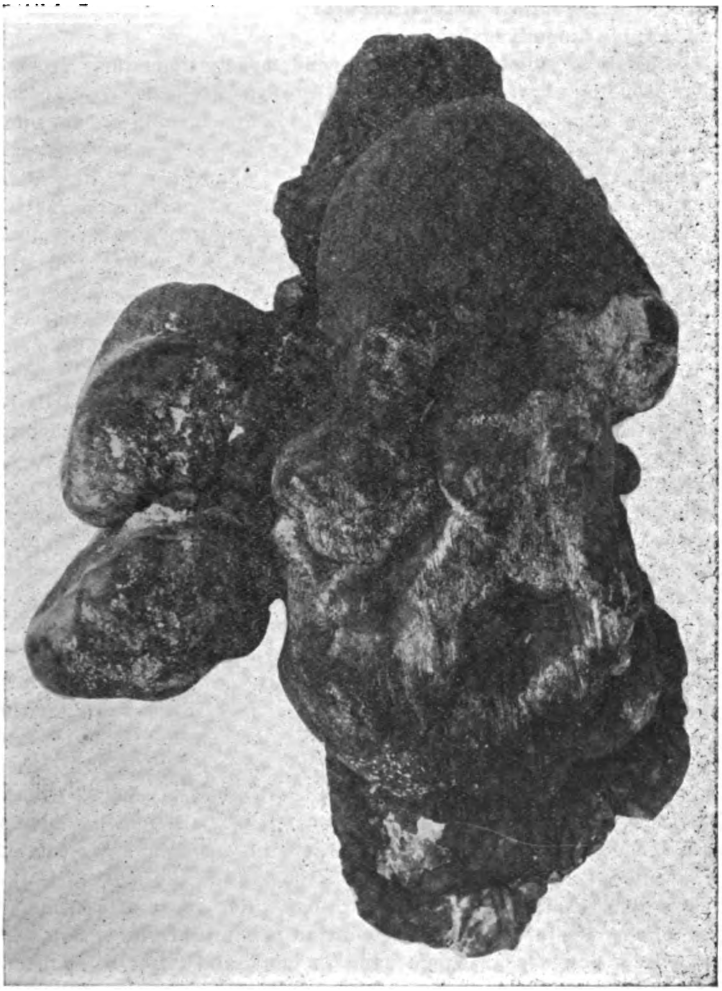

Fig. 1.—*Fomes annosus.* This is the most common and most destructive fungus occurring on pine and other coniferous timber in mines.

materials. Likewise many mines are situated in regions long cut-over and the local wood available is often young second-growth or the older trees culled by the logger. These latter often contain a considerable amount of heartrot.

The kinds of timber employed depend largely upon their accessibility, and the character of the local growth often gives us a good indication of what we may expect to find in the mines. In some localities, however, as the anthracite region of Pennsylvania, the local supply of timber is so far exhausted that pine is shipped in from states farther south, whereas formerly considerable native oak was used. The Alabama mines use a mixture of yellow pine and native oaks; the central states, such as Illinois, Iowa and Missouri use a large proportion of native hardwoods; the Michigan mines have largely relied on birch, maple, hemlock and tamarack; the western mines use for the most part Douglas fir, western hemlock, western yellow pine, lodgepole pine and Engelmann spruce. With this variety of host plants we can readily see there will be some diversity in the species of mine fungi encountered in different regions of the United States, although there do not appear to be nearly as many as speculation would lead us to believe.

Timber is destroyed in the mines by breakage, decay, fire, insects and wear, breakage and decay being the more important factors. The rate of destruction depends upon the species and condition of the wood when set and the meteorologic and geologic conditions of the environment. The loss of timber from breakage, wear and decay will be the only factors discussed in the present paper.

The breakage of timber due to "squeeze" varies greatly in different mines and in different mining regions. In many mines the pressure is sufficient to break the timbers before they have time to decay, and is often worse in some parts of a mine than in other parts of the same mine. Again, it may be bad at certain times, and then be somewhat relieved. The amount will depend largely upon the character of the rock in which the operations are carried on. Generally, in the newer portions of a mine the ground is the least stable, while in the older workings, after years of settling, it may finally attain nearly to a condition of equilibrium. "Squeeze" and decay, however, often go hand in hand, the latter often being the determining factor in causing failure.

Wear on mine timbers is mostly confined to the haulage ways, and is necessarily greatest on ties in passages where mules are used for transporting the minerals and waste rock to the exits. In some cases where the decay is slow and the wear intense, ties will be completely worn through the middle before they show any appreciable decay.

We now come to the question of decay and the factors influencing it. A suitable moisture supply, a favorable temperature, and the presence of wood which can be readily attacked, are the principal factors in accelerating the action of wood-destroying fungi in timber.

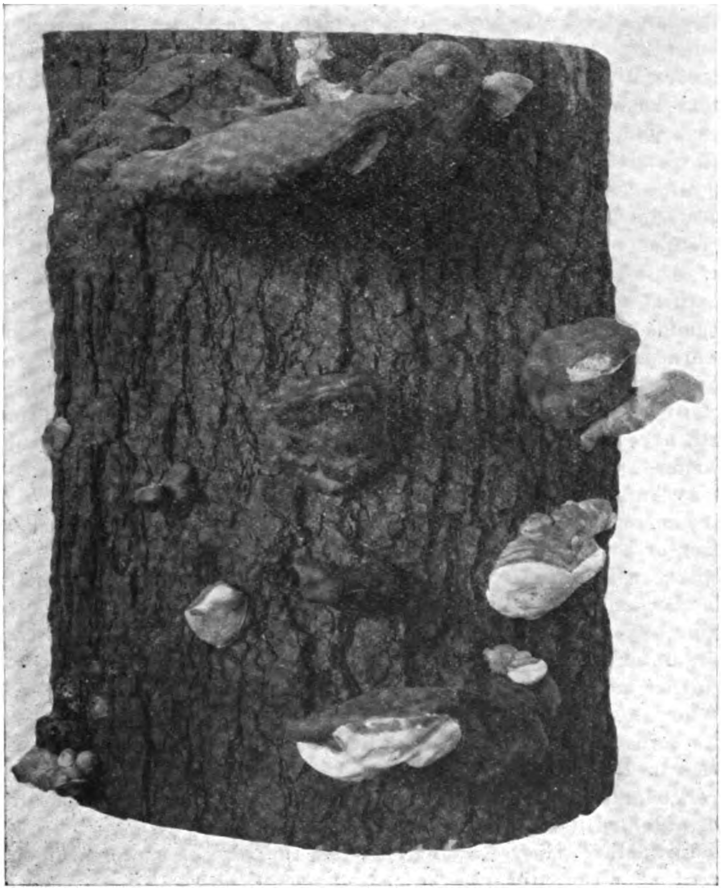

Fig. 2.—*Fomes applanatus.* Section of a hard maple timber in service in a Michigan iron mine for about two years. The wood is thoroughly rotted. This fungus is found quite commonly in mines on hardwood timber.

The first thing that attracts the attention in exploring underground workings is the elimination of the diverse atmospheric conditions as they exist at the surface. A mine, or a given portion of a mine, is characterized by uniformity in respect to these conditions, rather than variation. It is true that many mines are wetter, or cooler, or warmer, than other mines, and it is generally the case that in any one mine different levels, or different portions of the same level, are often at wide variance in their temperature or humidity, but within these more or less limited areas, if variation occurs, it does so only at long intervals, with the exception, perhaps, that when ventilation is improved, the condition may be artificially changed. Good ventilation tends toward a reduction in the degree of variation.

Mines are ventilated either by natural or forced circulation. The entering air is termed the "intake" and the exhaust air the "return." According to Harrington[1] the temperature and humidity of shallow mines less than 1000 feet deep and those dependent on natural ventilation are markedly affected by fluctuations in the outside air. Shallow mines are likely to be cold in winter and warm in summer, especially if the air velocities are 500 linear feet per minute or more, but in mines 2000 feet deep, or more, especially when provided with forced circulation, variations in surface air have little influence on general air temperatures. The same writer, speaking of conditions in the Western metal mines, states that "in deep mines, especially where there is moisture . . . in the surrounding wall of the intake air course, and at depths of 2000 feet or more below the surface, air rarely leaves the intake air course with a relative humidity less than 70 per cent, irrespective of the humidity of the surface air," and "only rarely is the relative humidity of the air as low as 85 per cent a few hundred feet from the intake." The air as it courses through the mine takes up further moisture and becomes warmer as it reaches the lower levels. When this air starts on the return trip from the lower portions of the mine, it cools as it reaches the higher levels, with a consequent rise in relative humidity, which very often reaches saturation, a very slight further drop in temperature then causing condensation of water on the surface of the timber.

In another paper Harrington[2] cites the case of a cross cut on a return air course where the rock temperature was 72° F. The air from the lower levels entered this cross cut at a temperature of 82½° and a relative humidity of 98 per cent. Two hundred feet from the point of entrance, the temperature dropped to 81½° and moisture began to deposit. When the air entered, the upcast shaft its temperature had dropped to 79°, and, of course, was still saturated. This means that large quantities of water were distributed along the entire cross cut.

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[1] Harrington, Daniel. Ventilation in metal mines. Dept. of Interior, Bur. Mines, Tech. Paper 251, 1921.

[2] Harrington, Daniel. Decay of timber in return air courses. Eng. & Mining Jour., Oct. 8, 1921; also as Bulletin 133 of the Cement Gun Co., Inc., Allentown, Pa.

Other data secured by Williams[1] indicate that for eight coal mines in Illinois, the return air averaged 64° for room and pillar mines and 75° for long-wall mines, while the corresponding humidities were 96 and 94 per cent, respectively.

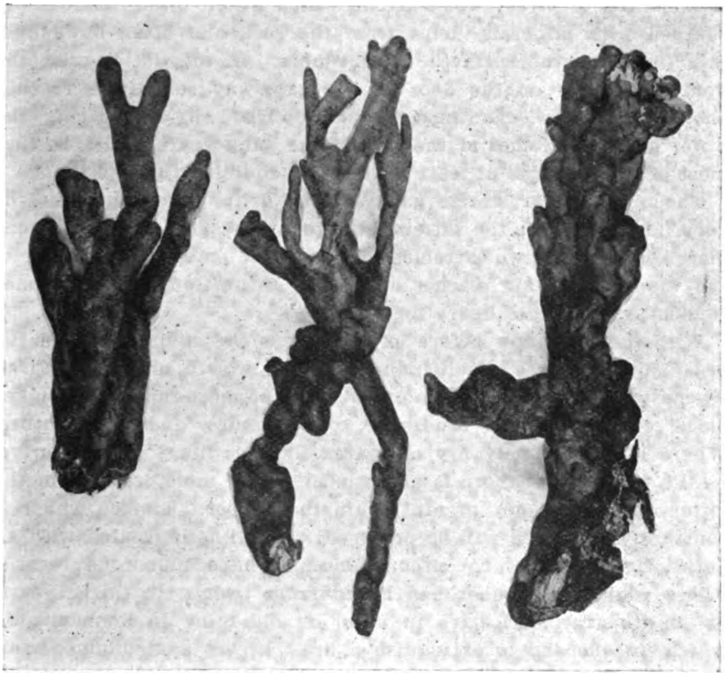

Fig. 3.—*Fomes applanatus.* Compare these "staghorn" fruit-bodies with the more normal ones shown in Figure 2. Most fungi of this type become very irregular in form when growing in the dark.

The above data will serve to give you a general idea of moisture conditions underground. The situation may be less exactly stated by saying that temperature conditions may range from perceptibly cool, so that a coat feels comfortable, to most uncomfortably warm and stifling. The highest temperature the writer encountered was in one of the very dry stopes of a Colorado mine where the temperature was said to reach 120°. Generally, though, the temperature is usually quite comfortable, ranging between 65° and 80°. It should be kept in mind, however, that there may be considerable variations in both temperature and humidity in various parts of a mine.

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[1] Williams, R. Y. The humidity of mine air, with especial reference to coal mines in Illinois. Dept. of Interior, Bur. of Mines Bull. 83. 1914.

The moisture content of the rock may vary from a dry condition, in which the surrounding rock and timbers show no visible traces of moisture, to a very wet state, in which water, often considerably charged with minerals, drips from the rock and often flows in a thin film over the surface of the timber. In this latter case, the mud and water on the floor of the gang-way sometimes reaches above the ankles. Drainage is accomplished by conducting the water away in ditches at the side of the gang-way or drift, so that most of the passages at least have water coursing through them.

The miners characterize gangways or drifts as either "wet" or "dry," including in the latter class such passages as are intermediate between the two extremes. In the "wet" gangways necessarily the vapor in the air reaches a point of saturation, and sometimes condenses to produce heavy fog.

With the facts now before us as regards the environment of the organisms let us see how it influences their growth, and why. First, we may make the general statement that the most rapid decay takes place under medium conditions of moisture and temperature. Where it is extremely dry or extremely wet, fungi do not thrive. In the former case there is an insufficiency of moisture, and in the latter an insufficiency of air within the timber. Timber which is constantly saturated will be preserved as well as if treated with an antiseptic. Under such circumstances I have numerous records where coniferous timber has lasted from twenty to thirty years. As an illustration, I have in mind an old mine in Pennsylvania which was flooded to extinguish a fire. It was again pumped out after a long series of years with the idea of resuming operations. Upon examination it was found that the completely submerged timbers were sound as on the day upon which they were covered.

This preservative effect is explained by the fact that it is essential for the growth of fungi to have a certain amount of air, rather oxygen, within the timber. The primary effect of excessive moisture, then, is to reduce, or exclude, the available supply of oxygen.

You thus see why I have talked so much about timber, temperature and humidity. These are the factors upon which decay hinges. Without the high humidities, the favorable temperatures and the presence of wood which readily decays we would have no problem to discuss.

The fact so often pointed out to me by mine operators that timber shows the briefest life in galleries ventilated by return air is readily explained when we know that air as it circulates through the mine takes up moisture and usually rises in temperature, and also loses some of its velocity as it progresses. High humidities mean moister timber more suitable for decay; higher temperatures, up to 80–85° (*Fomes annosus*, the worst enemy of coniferous timber in mines develops luxuriantly at 97° F.), mean greatly accelerated growth of the wood-destroying fungi present in the mine; non-durable species of timber mean a readily available food supply for the organisms. The stage could not be better set for a Fungus Festival!

The next question is—What are we going to do about it?

Changes in the ventilating system may in certain cases lessen decay by reducing the moisture content of the air, especially in return air courses, but this can apparently be of only local application. Substituting cement, iron, or other non-decaying materials for wood may offer relief in some cases, but when all is said and done the mining industry will never get away from the use of wood as long as timber is available. This means wood preservation.

Much of the timber in a mine, however, will not need to be treated, and local conditions will determine this. For permanent haulage ways or portions of a mine which must be kept open beyond the life of untreated timber, where decay is the principal cause of failure, antiseptic treatments are indicated.

Harrington has recently endorsed the Gunite system of encasing mine props in a ¼ to 1 inch casing of cement mortar, principally, I infer, as a fire-preventive. He discusses service tests made in a return air course in the properties of the North Butte Mining Company, where the normal life of 10 to 14 inch round peeled Douglas fir was but 4 to 8 months. Various treatments were carried out, including pressure treatments with creosote, spraying creosote on the timbers in position and covering both treated and untreated timber with cement mortar by the Gunite method.

The untreated timber was reported as failing in less than eight months while most of the Gunite treatments, even when applied to untreated timber, appeared to be absolutely sound.

The paper clearly states that there was practically no weight for the timber to support. The encased untreated timber could have been severely rotted and still have sufficient strength to hold its position in the absence of rock pressure. The method of inspection would give very little indication of the soundness of the wood beneath the coating, and judging from our general knowledge of the way timber behaves in such circumstances, it is quite safe to conclude that it would, in the untreated state, deteriorate at least as rapidly as if it had no cement coating. Likewise, any advantage of cementing over creosote has not been demonstrated by the experiments, as far as preventing decay is concerned.

MR. HUMPHREY: All I have attempted to do is to give you a general idea to take home with you, the idea that conditions in mines are very favorable to the growth of fungus and decay, which I think is sufficient argument for wood preservation in places where such preservative treatments are indicated.

THE PRESIDENT: Gentlemen, we have just had a very full exposition of what the problems are in mine timber preservation. I which we had more time to talk about it, and there is an opportunity at this time for any one who wishes to ask any questions about it.

MR. DREFAHL: Mr. Chairman, I would like to make a statement of observation that I made at the time you so kindly asked me to accompany you to some of the large anthracite collieries in the East. The things I was most impressed with were the following: It is an easy matter for any layman who knows nothing about preservation to go under ground and be impressed with the wonderful work that could be accomplished by the use of treated timber. I saw mine timbers which had been pressure treated with creosote, zinc, and sodium fluoride, still in a state of perfect preservation after a 10-year period. I asked the question: Why do you not use this stuff more than you do? The answer came in a sort of haphazard way. It is kind of hard to get it across with the management. Well, we are all in industry, we are all in business, and a lot of big bodies move slowly. It is a pretty hard thing to get some of these things across. I think one of the most lamentable things in the wood preservation game is that the industry does not have a number of consulting engineers who can be called in to consult with some of these industries that need help, and be given help along several lines. First of all, if these consulting engineers had an intimate knowledge of the art of wood preservation, if they had a knowledge of the cost of putting in the necessary equipment, and if they knew something of the economics involved, I do not think there would be any trouble in getting the idea of wood preservation sold to a lot of these collieries where much treated material can unquestionably be put in to advantage. Treated timbers can not be put in everywhere to advantage in mines. I am pretty well convinced of that, but I do think there is not half enough treated timber used. The effort has not been made and can not be made until you get somebody that can act in a consulting capacity and go in there and do these very things. It does not want order takers. It does not want mere salesmen. It wants somebody that knows the whole story to put it over, and from what I have seen of the situation, any one that has the facts is not going to have much trouble in convincing the executives in any branch of the mining business that wood preservation will work out to their advantage.

MR. CHURCH: Mr. Chairman, I would like to ask Mr. Hunt a question. Perhaps it is not a very diplomatic one, but I think it is fair. I would like to know whether the Forest Service has really sold this wood preservation proposition to the Bureau of Mines. Now it is all very well for the people who are treating timber and selling preservatives to go to the individual companies. They are doing that, and they are advertising in the mining journals, but have they any support on this proposition from the Bureau of Mines, whose pronouncements carry such weight with the mining people, and who reach them all directly and closely?

MR. HUNT: Some evidence of the fact that the Bureau of Mines is interested is this paper by Mr. Hornor. I talked with Mr. Van Siclen, who is one of the men holding an important office in the Bureau of Mines, Engineering Branch, and he was very much in favor of it. Mr. Hornor, the man who wrote this paper, has resigned from the Bureau on account of certain business affairs, which he had to take up and which are occupying his whole time. That has put a damper on their work for the time being, but they said that they expected to remedy that just as quickly as possible, and get another man who will spend his whole time on this subject. As a matter of fact, during the last year the Bureau of Mines has spent more time on this proposition than the Forest Service. Mr. Hornor was in the field from May until about November, visiting metal mines in the western states. He would go to the mine and go through the mine with their superintendent and talk to the managers and engineers, and find out all he could from them and give them all the information he could.

He went to one place and the manager spoke to him rather sharply saying, "What does the Bureau of Mines want to butt in on this thing for when the Forest Service has been doing it for a number of years. This is just another case of duplication of Government effort and a waste of Government funds." Well, Mr. Hornor was able to pull out and show him some letters and an agreement or understanding between the Forest Service and the Bureau of Mines which shows that there is no overlapping and no waste of money, but both bureaus are trying to all they can to promote the work which we both agree is so important. I think you can count on the entire support of the Bureau of Mines.

THE PRESIDENT: Are there any other remarks in connection with this subject? We have here a few representatives from the mining industry. If they care to ask any questions at this time we would be pleased to endeavor to answer them. The point Mr. Hunt brought out in his paper that the time for experimentation is over is probably very true, but some people still have to be shown, though we have examples of where successful mine props and timber preservation has paid, and is paying wonderfully well, in various parts of the United States that should serve as proof of what can be done if the proposition is handled properly.

MR. GERHARD: I think the most work should be done on the executives. There is many an engineer or manager or superintendent of a property who would like to use preservatives, but they have not the ability or the time to present those advantages to the moneyed end of the company, and I think that more work should be put on that end, and they will instruct their men to look into it.

THE PRESIDENT: The next paper will be by Mr. Shinn on "Treated Car Sills and Decking."

MR. SHINN: I have just one word I want to say, before I start to read this paper, and that is at the time the discussion came up as to whether or not I should write the paper I was not aware of the fact that there was a committee on Car Construction Material. As a sort of apology to the Committee I am making this statement, because I have recommended in this paper that a committee be appointed to go into this further. I wish to say just these few words as an explanation to that Committee, of why I have made that recommendation.

THE PRESERVATIVE TREATMENT OF CAR SILLS AND DECKING

Forrest S. Shinn

To date the Burlington Railroad has treated 1,297,188 board feet of car sills and 1,815,804 board feet of car decking. These were treated with the straight creosote process in the following years:

YEAR	SILLS Board feet	DECKING Board feet
1911	104.700	115,728
1912	409,764	1.087.116
1913	339,720	153,012
1914	223.500	89,892
1915	53,736	56,688
1916	166,068	176.796
1917		79,888
1918		56,688
Total	1,297,188	1.815.804

We are not in a position as yet to know just what results will be obtained from this treatment, as none of the lumber has been taken out for any cause except on account of being broken; however, in view of the fact that we are taking out yearly a large amount of untreated flooring on account of rot we feel that the money spent for treatment has brought good returns. We have not made any tests on this material, comparing the strength of the treated lumber with the untreated, but from close observation have come to the conclusion that treatment very materially increases the hardness and makes it much more resistant to wear. We find that many untreated planks in cars built in 1911 and 1912 have been worn so thin that they had to be replaced.

In November, 1921, we removed for inspection two treated planks from the end of C. B. & Q. car 67391, built in May, 1912, with treated sills and flooring; two treated gangway planks from C. B. & Q car 67190, built in February, 1912, with treated sills and flooring; and two treated gangway planks from C. B. & Q. car 68729, built in September, 1915, with treated sills and flooring. There was no sign of decay on either the sills or flooring. The planks were slightly worn but were perfectly sound and, from all appearances, were good for as many years more life as they had already given. On the same day that we removed the above plank for inspection we also removed two untreated gangway planks from C. B. & Q. car 67261. This car was built in March, 1912, with treated sills and flooring, with the exception of the gangway plank which was not treated. These two untreated planks were warped, shattered on the ends, and worn down to less than half the original thickness.

In the last month I have inspected 200 stock cars built in 1914 or earlier, 100 of which were built with treated sills and decking and 100 built with untreated sills and decking. The treated decking is in as good condition as when first laid down, showing no signs of decay, warp, or check, while the untreated decking is badly warped or buckled and all of it is more or less checked, and in a large percentage the ends are badly shattered. This shattering I believe is due mostly to decay, as in practically every case the shattered planks show decay on the end.

I have seen a few sills in cars built in 1911 or later that show signs of decay but not many; therefore, the treated sills have not been in service long enough for us to get any accurate data on the results by treating them. We feel that some time in the future we are going to be able to prove conclusively that the treatment of sills is justifiable. I have seen many decayed sills in cars built 1900 to 1906 and I am sure that everyone will agree with me that a well treated car sill will never show any signs of decay unless it was decayed before treated.

In addition to the treatment of sills and decking for stock cars we treated, with the Burnettizing process, sub-flooring for one dining car that was placed in service May, 1921, and one that was placed in service June, 1921. We also treated sub-flooring with the Card process (zinc chloride and coal tar creosote) for two dining cars that will be placed in service in the near future. We have found that the sub-flooring in the kitchen compartment of these cars rots out very quickly and are sure that we can overcome this by preservative treatment.

We have not treated any floors or sills for open top coal cars or flat cars but while this flooring is not subject to conditions that will produce rot as quickly as in stock cars, I believe that from an economic viewpoint we would be warranted in treating it. I have seen hundreds of these cars where the flooring showed signs of rot to a very considerable extent and it is a very common sight to see where the sapwood along the edges of the planks has sluffed off, leaving the top of the plank in the shape of a half moon. This very materially weakens the floor causing it to finally break and while the records show "removed account broken" the main reason that it broke was because it was decayed.

There is a question in my mind if we are not wasting oil by pumping in 12 to 14 pounds per cubic foot. I believe that we may be able to obtain a good effective treatment by one of the cheaper processes than the full-cell creosote process. I would recommend that a committee be appointed to go into carefully the treatment of car sills and decking and I would further recommend that they be instructed to take into consideration the various processes of treatment.

The time has undeniably come when the necessity of the conservation of our forest supplies, as well as the increasing demands for the economical operation of our railroads, makes it prohibitive for us to use untreated lumber any place where we can appreciably increase its life by preservative treatment.

THE PRESIDENT: We have to give the Burlington credit for doing things, whether they do them right or wrong. This is certainly one of their ways of doing things right, and they wish to do it so right that they will put twelve to fourteen pounds of oil into car timbers. I can't see how the company is doing that, and at the same time pay its wonderful extra dividends. Discussion on this subject is now in order.

MR. HARPER: I would like to ask Mr. Shinn what kind of timber this was.

MR. SHINN: It was all fir timber.

MR. GOLTRA: I would like to ask Mr. Shinn if all of the lumber and sills were treated by the pressure process.

MR. SHINN: All treated by the pressure process.

MR. GOLTRA: And all with creosote?

MR. SHINN: All with straight creosote process.

MR. GOLTRA: What was the reason for using creosote instead of chloride of zinc, when you use chloride of zinc mostly for the treatment of your ties?

MR. SHINN: That is a question I am not in a position to answer, as I was not with the Burlington at the time this treatment was made. I would suggest that you ask Mr. Waterman.

MR. MEYER: I believe I can answer that question, because it was under my supervision that all this material was treated. The reason was this, Mr. Goltra. We felt the zinc chloride would leach out of the floors or decking of stock cars and consequently also out of the car sills, and to get as stable a preservative as possible we felt we could not do it too well. That is the reason why we used the straight creosote, full-cell process, and I believe the time will come when every man will agree with us that we did what was right, and that it was money well spent.

MR. WATERMAN: Mr. President, I don't want to say very much on this. I personally believe in doing things well. One time I made a talk on wood preservation, and this question was asked me: "What is the best treatment?" I shall never forget the answer. I said, "If creosote was as cheap as water, everybody would use creosote." Most of the car sills today are steel, but you can treat the decking of stock cars with creosote, and it will last until it wears out. Decking is always more or less sap on the 6-inch and 8-inch planks, and the life of that car decking or flooring is the life of the sapwood, which is 2 or 3 years. If anybody doubts that and does not agree with me, I will be delighted to have you stand up and contradict it.

We treated stock cars in 1911, the first ones, and then in 1912, 1913 and 1914. I have diligently inquired from the car-repair men to find where any of the decking was ever removed account of decay. Sometimes it was abused, a heavy piece of casting would fall on it and break it, and then they had to put in a new piece. I can take you on the Burlington, where they have stock cars, and show you hundreds of them where the decking and sills are treated with creosote. I would be delighted to have you examine them. You know that a car deck or floor is a place where wood will decay as rapidly or more rapidly than almost any other place on account of the service to which it is put. Look at the car decking we have treated, and you will find it is harder three years after it is in our stock cars than it was when we treated it. It becomes almost as hard as a bone, and I can't see what our Forest Service people can do which would advance the interests of wood preservation more than to encourage the treatment of all material for car use that will not damage or contaminate the merchandise transported from one place to the other in the car.

MR. ANGIER: Mr. President, I would like Mr. Waterman tell us the best way to treat car roofing.

MR. WATERMAN: What kind of a car roof?

MR. ANGIER: Box cars, stock cars.

MR. WATERMAN: Wait a minute, pine, or fir, or what?

MR. ANGIER: I was asking how you would treat it.

MR. WATERMAN: I would treat it just the same as I treat ties, I would use creosote.

MR. ANGIER: How about creosote being slippery?

MR. WATERMAN: I don't think that would effect it at all. I would not put twelve pounds per cubic foot in it. I would treat it with a light treatment.

MR. ANGIER: Why not treat it with zinc chloride, or sodium fluoride?

MR. WATERMAN: I don't know. I have not had any experience, and I am not going to tell you about something I don't know anything about (laughter). I do know if you treat car roofing you could not treat the roofing of box cars or at least the bottom could not be treated because it would destroy the merchandise which would be hauled in the car, but the top could be treated. So far as being slippery, I don't think there is anything to that.

MR. ANGIER: I think Mr. Sackett said that 100 per cent of the failures of car roofing were due to decay. If that is a fact we ought to treat our car roofing.

MR. GARRETT: Mr. Chairman, I would like to ask Mr. Waterman what penetration he gets in fir decking.

MR. SHINN: A thorough penetration, through and through.

MR. WATERMAN: And that was fir, the kind that you use.

MR. GARRETT: The question I had in mind was, would it be cheaper to buy good fir decking than it would be to treat low grade decking? Ninety per cent of our decking that we remove is broken and mechanically worn out.

MR. SHINN: That is very true. There is one point in my paper where I have stated we have observed that the treatment of car decking very materially increases the hardness of the decking and makes it more resistant to wear. We have found car after car built in 1911 and 1912 with untreated decking worn so thin that it had to be replaced. I have never seen a piece of treated car decking laid down in 1911 worn practically at all. It is slightly worn, but it does not wear nearly as much as treated decking will. I have tried to chop into it with an axe, and it is like chopping on a bone or a piece of iron. You can hardly chop it. It can be chopped, but the chopping is altogether different from untreated lumber.

MR. GARRETT: Most of our decking is for use in flat cars and gondolas. If you can convince me that treatment with creosote will help a floor when they use clam shell buckets to unload it, I would like to be convinced.

MR. SHINN: I have seen many a flat car that was buckled and shattered so badly that the clam-shell bucket just tore the ends of plank to pieces. I have looked and looked, and I have never seen a case of buckling in treated car decking. It won't buckle. Another thing, in flat cars I have seen many and many a plank where the edges were all gone. Undoubtedly it was the sapwood that had rotted away. That plank would later break. Why? Because it had rotted away. The records won't show rot, because it is broken, but the edge is all rotted and there is only half a plank left, and naturally it will break.

MR. GARRETT: I think there are lots of places for treated timber in car construction, but I can't agree with all you say. In refrigerator cars lumber rots, and rots fast, faster than in any other class of equipment. If you can get something that will treat and preserve that timber, where it is moist all the time, you will be doing something I am not convinced is humanly possible. It is not economy to treat lumber that will be destroyed mechanically before it rots.

MR. WATERMAN: How long will your deck, untreated, last—let us call it flooring, and then everybody will understand.

MR. GARRETT: In our box cars almost indefinitely, except in the doorway.

MR. WATERMAN: What kind of wood is it?

MR. GARRETT: Douglas fir.

MR. WATERMAN: Last indefinitely?

MR. GARRETT: Yes, sir. That is, as far as rot is concerned. It will wear out mechanically in the doorway. We have cars built in 1890, along in there, 1898, and 1900, and the decking is in the cars yet, outside of the gangway. We buy select common fir decking.

MR. WATERMAN: You are a Milwaukee man, aren't you?

MR. GARRETT: Yes, sir.

MR. WATERMAN: You and Sackett had better get together and put your dope in the same sack, and stir it up a little and dump it out.

MR. GARRETT: I am giving my experience. I have been in the car business forty years.

MR. WATERMAN: Does flooring last forty years?

MR. GARRETT: It isn't like ties. It won't last forty years.

MR. WATERMAN: I would treat every foot of car flooring that was put in a car if I had my way, where it would not affect the material which you transport over the country.

THE PRESIDENT: I think the thing that we have to contend with in car conservation work, as far as timber is concerned, is cooperation with the fellows who have to do car repairing, and try to get them to decide whether the stick was taken out on account of mechanical wear, or on account of rot. As Mr. Shinn has brought out, a lot of material is taken out of cars because it is rotten, rather than because it is worn out. It is taken out because of breakage, and the breakage comes from decayed wood. There is a great opportunity for railroad men to really sit down and study car repairs as they actually take place, and have everybody convinced as to why various timbers are taken out of cars. Mr. Waterman undoubtedly has proven to his satisfaction that it is a paying proposition, even with a full cell process. I would like to ask Mr. Shinn why the figures in this paper stop with 1918.

MR. SHINN: Well, they stop in 1918 because since that date we have been unable to get enough creosote, and so we have not treated any car sills or decking.

MR. WATERMAN: We have not had any creosote for three or four years.

THE PRESIDENT: To the outsider it looks peculiar that the figures end in 1918. I believe it is desirable to show that the reason was the shortage of creosote oil. Are there any other remarks?

MR. WATERMAN: I would like to have Mr. Shinn tell you about going to Aurora, one of our largest shops, and talking to the foreman, and what he told him about this treated decking.

MR. SHINN: I think it might be well to repeat the remarks that the foreman of the repair shop made to me. When I first introduced myself, and told him what I wanted and what I was trying to do, that I was trying to further the interests of treating car decking, he told me that he hoped very much that I would succeed. He said, "The biggest mistake that the Burlington ever made, I think, in connection with the building of cars, was made at the time that they quit treating the car decking."

THE PRESIDENT: Do you get that point? That was from the superintendent of the car shop.

MR. WATERMAN: That is from the fellow right on the job, in the biggest shop we have.

MR. FULWEILER: I have heard several times here that we can't use creosote oil for treating certain lumber in refrigerator cars or other cars on account of the damage it might do to the contents, I wonder whether you have really gone into the matter to determine whether the contents will really be damaged or whether you are likely to assume it. The reason I say this is because we had trouble in one of our buildings. The flooring was laid directly on concrete. The flooring would last about four or five months. We finally gave the wood a very light treatment with a light distillate oil from water-gas tar and the floor has been in there ten years. That is a creosoted floor in an office building. It seems to me if it didn't give any trouble there it certainly would not do very much harm in box cars. It would appear to be worth while to investigate the question further before we place an absolute bar against the use of treated material for this purpose.

MR. GARRETT: Butter and cheese are very sensitive to odor, and I am satisfied that creosote would not be acceptable for refrigerator cars if you were hauling butter or cheese in it.

THE PRESIDENT: I think Mr. Shinn brings out the fact that the Burlington treated some part of their dining cars.

MR. GARRETT: I am talking about refrigerator cars.

THE PRESIDENT: This was in the kitchen of dining cars.

MR. SHINN: We treated the subflooring in the kitchen, and not only the kitchen but the entire car. However, we found the most trouble from rot over the kitchen where it was always wet.

MR. WATERMAN: We treated some of that with zinc, and some with creosote. We are keeping a record of it, and later we will be able to tell you what results we obtained. The subflooring rots very quickly in the kitchen. I could not tell you how quickly.

MR. MANDENBERG: Relative to the treatment of refrigerator cars, I think there was an outfit in Milwaukee that was treating sills, subflooring and subdecking with creosote oil, and had been for a number of years, and they report absolutely no contamination of contents. However, very recently one of the western roads told me that they had a number of law suits because of contamination. In running the matter down I found they had used box cars, because of a shortage of flat cars and gondolas, to transport creosoted ties. Later some creamery concern put in butter and cheese, and these naturally took up the creosote odor and they had a suit on their hands. However, I want to get up and support my friend Mr. Shinn. I have had the pleasure of visiting a great many railroad shops and I find that the railroad shop fellows, from the big men down to the fellows driving nails are kidding themselves along as to why timbers really fail. The most of them will say that the timbers fail mechanically when the real basic reason is that decay has weakened that timber beyond the safety point, and the material can't stand up.

DR. COLLEY: I think all you men who are talking about timber breaking and wearing out mechanically should take cognizance of what the gentleman has just said. The early stages of rot are practically impossible for the layman to detect. The early stages of rot weaken the wood. The weakened wood will wear out, and the weakened wood will break before what some of you might call rot has shown itself at all. Creosoting and preservation will prevent that incipient decay.

MR. COOPER: We shipped some flour in a box car where there had been creosoted ties. The flour was affected and after analysis by our chemists the company paid for the flour.

THE PRESIDENT: Are there any other remarks in connection with this subject? When you railroad fellows get back you will hear, if you have not already heard, that the officials of all the railroads of the United States are now investigating this problem of wooden car repairs. I would ask that we leave the problem until tomorrow morning when this question will come up again under the report of a committee Are there any other remarks in connection with this paper by Mr. Shinn? If not, we will take up the next subject.

MR. MOSES: The question is just asked here as to whether treatment of one inch car roofing would affect the matching; in other words, whether or not it would get out of shape, lumber as thin as that.

MR. SHINN: It will not affect it. I have experimented with it myself.

MR. WATERMAN: My opinion is that it would not affect it.

THE PRESIDENT: If there is no further discussion we will take up the question of peeling ties.

REPORT OF COMMITTEE No. 6-1—PEELING TIES

To the Members of the American Wood Preservers' Association:

The work of this Committee is to develop standard methods of peeling ties. This problem is limited to the North Central States. In other parts of the United States ties are delivered stripped of bark. In most cases in the South, the bark from the larger ties is gotten rid of by hewing or sawing the ties on four sides, and all ties are delivered peeled. While the practice of cutting off the sap wood saves some freight and allows more ties to be shipped in a car, it is considered questionable by many, as the sap wood takes the treatment most easily and helps to strengthen the tie. We believe it should be allowed to remain on the tie.

In the North, tie peeling is a serious problem. Your Committee has given the matter much thought and investigation, and its recommendations are given below:

1. Ties should be peeled by the maker. The work of making the tie is not complete until bark is removed, because the tie is not in a usable condition with the bark on it. The sooner purchasers of cross ties refuse to accept them when only partly made, the better it will be for the tie industry.

The work of a treating plant should not be hampered by having to peel ties. Ties should not be seasoned with the bark on. The work of peeling should be done before tie leaves the woods or the mill, as the case may be.

2. When ties are peeled by hand at places where made, the work can best be done with an axe or a cooper's draw knife. Should the maker elect to hold his ties until the bark can be more easily removed, which in the North is between May 20 and July 15, a spud has been found the most effective tool.

3. When ties are made at a saw mill, many of them are square sawed, but in case ties are sawed on two sides only and the bark is to be removed, it should be considered a part of the process of manufacture and removed by mechanical appliances provided for doing the work. Saw mill men advise this is entirely practicable.

In this connection, your Committee made a test of an air planer, at the plant of the T. J. Moss Tie Co., Granville, Wis., all but one of the Committee being present.

The planer was located near a building containing air compressor and ties were brought to the planer. Sufficient ties for the test were piled near the planer before work was begun. It required one man to work the planer and one man to handle the ties to and from the table or supports where the work of planing was done.

Later on, tests were made of peeling ties by hand and the figures below are a comparison of the cost of the two methods. It was found that the air planer did the best work with air pressure of about ninety pounds per square inch.

STATEMENT SHOWING COMPARISON OF COST BETWEEN PEELING CROSS TIES BY HAND AND PEELING THEM WITH AIR PLANER.

Test made June 15th, 1921.

	No. of Men Employed	No. of Ties Peeled	Total No. Minutes Consumed	Ave. No. Minutes per Tie	Total Cost	Ave. Cost per Tie
			Dry Ties			
Air Planer	2	10	32½	3¼	$1.11*	.11
Hand Peeling	1	10	46	4.6	.30	.03
			Green Ties			
Air Planer	2	10	47½	4¾	1.48	.148
Hand Peeling	1	10	43	4.3	.30	.03

*Items of cost of work with air planer on dry ties:

Two men 32½ minutes at 50 cents per hr.	$0.54
Estimated cost of 90 lbs. pressure compressed air 32½ mins. at 50 cents per hr.	.27
Cost of bringing ties to planer—10 at 3 cents each	.30
Total	$1.11

Although it is not included in above statement, it is proper to take into consideration following items of cost in connection with the air planer:

Cost of planer	$350.00
Cost of 10 knivès at $5.00	50.00
Cost of air compressor	2,000.00
Cost of installation, including pipes	1,000.00

Also, there should be a charge for cost of maintaining machine, sharpening knives, depreciation of all machinery, etc. Just what this would amount to per tie, depends on how many ties are peeled.

It is the opinion of your Committee that if the air planer can be utilized, it would be best adapted for use at a saw mill where compressed air is obtainable at the time ties are being made, to aid in the process of manufacture. A large part of the cost in the Granville test was in getting the ties to the planer.

4. When necessary to peel ties at a treating plant, the Committee recommends that ties be peeled when received at the plant before being piled and that it be done on piece work basis. The bark should be cleared up daily and used as fuel.

5. Finally, it is the opinion of your Committee that the elimination of the tie peeling problem is largely in the hands of the railroads and others purchasing ties. If it is agreed by the various associations of railroad men, treating plant operators and tie contractors that no ties will be accepted from a producer that are not peeled, there will be no more trouble in the North

than there has been in the South for many years past. It is merely a question of getting the tie producer to do his work properly.

F. S. POOLER, *Chairman*
W. L. BACON
A. GIBSON
A. MEYER
T. G. TOWNSEND

MR. POOLER: It is a difficult problem for the producer to peel those ties, or at least it is a difficult thing to do in the north, because they are frozen solid at this time of the year, but nevertheless the bark can be chopped off with an axe, and we are requiring them to do it. Conditions might be different in other years, and we might not be able to put that over, but this year we are doing it to a large extent. It certainly is a problem that should not be faced by a treating plant because they have troubles enough of their own. I feel that the railroads should get their ties peeled. It is done in the south, and it ought to be done in the north.

THE PRESIDENT: Gentlemen, you have the report of Subcommittee 6-1, Peeling. It is up for discussion at this time. Are any of the other roads represented here who have to contend with this problem? Do you feel that the Committee is correct in the statement that the ties should be peeled before they arrive at the treating plant?

MR. MEYER: Mr. Chairman, any one who has had experience in plant operation and knows what it means to have ties come in the yard to be peeled, will appreciate what this report means. In the first place when ties are stored in the yard, more especially northern ties, and seasoned, they are more or less damaged with worms cutting the sapwood inside the bark, and this is one good reason why the bark should be removed just as quickly as the tie has been cut; second, by placing unpeeled ties in the tie yard you always have to leave room for peeling them, which means additional yard room, and additional tracks; third, if the bark is left on the ground when it dries it is a fire hazard, and a very great nuisance when it is wet. In the summer time it keeps fungi growing all over the yard, and we are unable to cope with them. In the fourth place, the bark should be kept cleaned up and burned for fuel. In a good many cases the bark is not worth while burning as fuel, because the fuel value is very low and the firemen can not keep up steam with it. It depends a good deal on what kind of bark it is. In my experience we had some bark that we simply hauled out some place, and burned, because every time we used it under the boiler our steam went down to practically nothing. So it seemed that the bark, instead of being an asset as a fuel, is practically worthless. I agree with the Chairman, and I think you people will agree with the committee that a tie cannot be considered a finished product before it is peeled, and should therefore not be handled at the treating plant.

THE PRESIDENT: Are there any other comments on this situation? If not, we will adjourn now until tomorrow morning at nine o'clock, so far as the continuation of our Annual Meeting here is concerned. However, at seven-thirty this evening we have a joint meeting with the Western Society of Engineers, and everyone is urged to be present and participate in the discussion of a paper by the Bridge Engineer of the Sante Fe System, Mr. A. F. Robinson.

EXPERIENCE WITH TREATED WOOD ON THE SANTA FE*

Long Service Given by Timbers and Ties Demonstrates the Value of Preservative Treatment.

By A. F. Robinson
Bridge Engineer, Santa Fe System

In the following narration we will consider the timber bridges first, later on the track ties.

The first creosoted piles were used in 1875 in an open-deck pile bridge across Galveston Bay, and it was rebuilt in 1895; when the Causeway was first finished the latter piles were removed and the larger portion of them were used again in building foundations for piers.

The first creosoted ballasted-deck pile bridges were put into service late in 1899. The same season we used creosoted timber flooring on a ballasted-deck steel bridge at Los Angeles. When the joint track elevation bridges were built in Chicago creosoted timber flooring was used for supporting the ballast. This was waterproofed. From 1900 on the use of creosote increased very rapidly, as by 1908 almost all timber used in bridges was creosoted.

I may note that the Louisville & Nashville and Southern Pacific companies used creosoted timber bridges some time before the Santa Fe adopted them.

From ten to twelve pounds of creosote per cubic foot of timber was first used for structures on land or fresh water. For structures in salt water, exposed to attack by marine borers, a much heavier treatment is required. At present piles for marine service receive a light steaming and then from 20 to 25 pounds of creosote per cubic foot of timber is forced in, or all the creosote the timber will take. For about ten years past southern pine has been treated by the "full cell process," some 14 to 16 pounds of creosote per cubic foot of timber being used. At all of the Sante Fe treating plants southern pine is air seasoned and then creosoted without steaming or at high temperatures. When we commenced using creosoted material the timber was seasoned by steaming.

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* Presented at the January 25, 1922, joint meeting of the Western Society of Engineers and the American Wood Preservers' Association.

Oregon fir was steamed or treated by the old "boiling process," but is now usually treated by boiling under a vacuum. Creosoting as done at our Somerville, Texas, and Albuquerque, N. M., plants does not reduce the strength of the timber, but prolonged steaming at high temperatures may reduce its strength from 15 to 40 per cent.

A new process, known as "needling," or perforating has recently been tried out somewhat extensively for the treatment of Oregon fir. After needling the creosote penetrates air seasoned fir deeper and more thoroughly than in the usual methods of treatment. Preliminary tests on this needled timber seem to show a loss of 10 to 12 per cent in strength. It is possible this process can be modified so that needling and treating will not cause any appreciable loss in the strength of timber.

Our bridge list, as of January 1, 1921, shows the following single-track lengths, arches, boxes and pipes being omitted and T-rail bridges being included:

498,757	lin. ft. open deck timber bridges.
222,520	lin. ft. ballast deck timber bridges.
120,307	lin. ft. open deck steel bridges.
147,995	lin. ft. ballast deck steel bridges.
2,411	lin. ft. reinforced concrete bridges.

Almost all of the ballast deck steel bridges have creosoted timber floors.

Creosoted ballast-deck timber bridges from sixteen to twenty years old seem to be in perfect condition and give promise of being good for from fifteen to twenty years of service. These may, therefore, be considered as permanent structures. Some 38 per cent of all our bridges are ballast-deck and almost 50 per cent will be termed permanent structures. Based on main lines only, some 68 per cent of all bridges have ballast decks.

I may note no open-deck bridges of any kind have been built on our main lines during the past ten years, except after washouts or burnouts.

The total length of bridging on the system is slightly less than 188 miles, or 991,990 lineal feet single track.

Creosoted timber bridges had not been in service very long before we found there were many things to be learned about cutting, handling and curing before treatment; also, handling the treated material and building the bridges. Below I am giving some of our troubles and the method of overcoming same, so far as we have been able to overcome them.

During 1909 and 1910 we had many complaints about rotten piling on our Beaumont Division. This extends from Somerville, Texas, to Longview, Oakdale, Beaumont and Port Bolivar. In this territory timber seems to be more readily affected by decay than in any other part of the country traversed by system lines. A few miles east of Cleveland, Texas, we have what is known as an experimental section, where we are trying out all kinds of treatment on ties, fence posts, etc. This section was taken because the soil and climate seemed to be especially adapted to produce rot in timber, both treated and untreated. I spent about four weeks going over this division and examined every pile bridge in the closest detail. The complaints were well founded. I found, at least, two thousand piles that were rotting very badly. The piling and timber used was treated from 1900 to about 1907. Up to that time no rules had been made covering the time the material was to be left in the woods after cutting and the time it was to be cured before treating. I think many piles were treated which should have been culled. They were left in the woods several months and the material had actually commenced to decay before it was taken to the treating plant. In cases of this kind treatment is wasted.

Piles after driving in the bents are sawed off for capping and our plans called for these freshly cut surfaces to receive a heavy treatment of hot creosote before the caps were applied. Notwithstanding this notation we found a large per cent of the piles were beginning to fail at the caps. There would be an outer layer or ring of creosoted sap wood which was good, but inside this there would be a ring of untreated sap wood which was rotting very rapidly. The caps were 12 inches wide and the piles varied from 12 to 18 inches in diameter. This would leave quite a portion of the pile head projecting beyond the sides of the caps. I found piles where I could put a 4-foot rod down in the rotten sap wood between the outer creosoted ring and the inner heart wood. In many cases a good deal of load was being carried by the outer creosoted ring of sap wood and but very little load by the heart wood. We found a good many cases of rot starting at or near the ground surface. Decay also commenced in holes bored for sway-brace bolts and for other purposes. It would always start wherever the creosoted surface was disturbed or bruised deeply.

Our men had the unfortunate habit of champfering off the sides of the piles at the cap so they would drain. Frequently they would cut out large chips or sections from the side of a pile in order to make the sway braces draw straight and in every case of this kind decay seemed to start very promptly, as the cut in the timber usually extended through the creosoted layer. Careful study seemed to show that the cause of decay was due to leaving the heads of the piles or some other portions unprotected or untreated.

Another source of trouble was the driving of the piles. I found a good many cases where the heart wood had been broken loose from the sap. The ordinary steam hammer has the lower end about 12 inches in diameter projecting through the driving block and striking the pile. A circle 12 inches in diameter has a little more than one-half the area of a 16-inch circle and only about two-fifths the area of one 18 inches in diameter. From this you will note the blow from the hammer was being delivered into the pile over an area of less than one-half its surface. The skin friction on the outer surface of the pile would hold it up and the hammer would drive the heart wood loose. In many cases I found the exterior ring of creosoted sap had been split vertically in the driving, so that the piling was really untreated, so far as decay was concerned. We overcame this by providing a driving head 18 inches in diameter which rested squarely on the head of the pile and was so arranged that the blow from the hammer must be distributed over the surface of the pile.

As a remedy for the above troubles we cut down the piles to good solid material and inserted framed bents or blocking of varying heights. When the piles were sawed the freshly cut surfaces were treated with three or four coats of hot creosote. A sheet of some kind of prepared roofing was then applied to it over the fresh coating and the creosoted timber bent put into position, it being drift bolted to the piles. These repairs were made more than ten years ago, and up to the present writing we have not been able to detect any more indications of decay.

When we cut out these piles the cross sections were examined very carefully and it was found that the creosote had penetrated the piles very irregularly. On one side the treatment would be almost as thin as a sheet of paper and on the other side it might be 2 inches thick, the thickness of treatment varying all around the surface of the piling. We figured that this was due to moisture in the piling, which resulted from the steaming and the improper seasoning.

When we opened up our own treating plant at Somerville the material was all of it carefully air cured and no steaming of any kind was done in the treating. As the result of this handling, we have been able to get a very uniform penetration of the creosote. On the other parts of the system we have had very few piles failing at the caps. That, of course, is subject now and then to slight modification. As soon as the trouble is detected they stop it, and the trouble has been overcome in the same manner as noted for the Beaumont Division.

Examination of the stringers in ballast-deck bridges where steaming was done in treatment showed a similar condition to the piling, but it was not so extensive. I may note that the trouble has not increased in ten years. The timber seems to be as good as it was ten or twelve years ago. We have in a very few cases found some of the outer stringers decayed on the upper surface, as a result of the irregular penetration of the creosote. I may note that where the timber is air seasoned and the treatment applied without high temperature we have not had any trouble from decay in southern pine.

I would also note in passing that where we refer to creosoting it covers material treated for air or fresh water surface and does not refer to marine treatment unless it is especially noted in in the text. When we first commenced air seasoning material at Somerville untreated timber sleepers were used for supporting the piles of timber or piling. It was not very long before we discovered these untreated timber sleepers were starting the growth of fungus or decay in the timber piled on same, this decay frequently extending clear to the top of the pile of timber. We very soon found that we must use either creosoted timber sleepers, steel I-beams or concrete for supporting the piles of timber and piling, as this was the only means by which we could get the timber properly seasoned without decay setting in.

A great deal of close attention is necessary in the air seasoning of timber piling. If the sap has commenced to turn or sour, treating will not be effective. It is probable different curing rules will be required in different sections of the country where the moisture conditions vary.

As the result of our trouble from rotting of piles at the caps we made quite an extended test on a field treatment of piles when cut for caps. With our first apparatus we were able to get about ⅝ inch end penetration of the creosote. Several first-class creosoted piles were cut into lengths of about 3 feet and also a similar number of untreated piles which were reasonably well seasoned. A part of these short creosoted specimens received the end treatment with our special apparatus. The other samples were painted with various kinds of preserving material and also several kinds of paint. After the coatings had properly dried these short pieces of piling were set up in a trench in the ground on our right of way two miles east of Cleveland, Texas. These pile butts were set in an exact line at the same elevation. A cap 12 inches wide and 4 inches thick was placed on top of the row of pile butts so that the test would be relatively the same as in the bent of a pile bridge. These pile butts project about 18 inches out of the ground.

We have examined these pile heads annually for eight years past. At present writing the samples of creosoted pile having pressure treatment on the ends and several of those receiving brush coatings on the ends are still in good condition. These investigations lead me to feel that a brush coating of hot creosote, will protect the freshly cut head of creosoted pile for a long time. As yet I am not certain as to whether it will be necessary to use the pressure treatment for the ends of piles since the brush coating seems to be giving extremely good results up to present time, and the application of this brush coating will cost considerably less than the special pressure treatment.

Investigations made seem to show that the following rules must be adhered to absolutely in handling treated timber.

1. Treated timber must not be cut, bruised or handled in a rough manner. Grab hooks or dogs should not be used in handling the material, unless the holes made by the hooks are carefully plugged with creosoted pins.
2. The driving of piles must be done with a hammer which will not split them or break the sap loose from the heart wood.
3. Any cut surfaces or bored holes must be carefully treated with hot creosote and holes plugged.

Where solid stringers are used in a ballast-deck bridge without any cross planking it is necessary to make end cuts on some of the sticks on account of the variation in panel lengths of bridges due to driving of piles. When a gang is driving piles, it is a very difficult matter to keep the bents absolutely 14 feet center. They frequently run a little one way or the other. As a result, now and then we have to cut off the end of the stringers over a cap. As with the solid timber stringers, the stringers cannot be lapped. They butt on the cap. These freshly cut ends must be thoroughly coated with creosote before the stringer deck is placed. A few years ago the Southern Pacific Lines in Louisiana and Texas removed the decks from fifteen or twenty pile bridges which had been in service about twenty-five years. These decks were made of a solid course of 12x12-inch timbers and the railway company was removing them because they were getting too light for the power being used. Examination of these stringers after being removed showed that they were in perfect condition as concerns decay, except where they had rotted in from the ends which had been cut after creosoting. There was an article in the Railway Age and Engineering News Record some years ago telling about these bridges, and I also had the good fortune to see a couple of timbers in the bridges when they were uncovered.

In 1910 we made up a new set of standard plans for ballasted-deck pile bridges. In these plans the stringers were spaced 7 inches apart in the clear and lapped by one another on each second cap, cross planking being used to hold the ballast.

The stringers called for in these new plans were 7x16 inches by 30 feet and they had a working depth of 15¾ inches. We soon found a sufficient supply of these 30-foot stringers could not be obtained within reach of our lines in Texas and Louisiana, and as a result the plans were adopted for territories using Oregon fir stringers altogether on our coast lines.

In open-deck timber bridges the stringers and ties are untreated, but for some years past the ties on open-deck steel bridges have been creosoted. The ties are always run through a surfacing machine and brought to exact depth. While Oregon fir may lose quite a percentage of its strength as a result of steaming or boiling at high temperatures during treatment, we have had no stringers break under traffic. Fir caps in bridges built under our old standard plans have, however, given some trouble. A good many fir caps are "boxed heart" pieces and our old ballast deck bridges had too many drift bolts through the stringers into the caps. The failures in caps were always in Oregon fir pieces. In most every case of failed caps I found the timber was actually burned or charred by treatment at high temperatures and the sticks broken up into rings, much like the layers in an onion. Culling "boxed heart" pieces and holding the boiling temperature to a maximum of 220 degrees Fahrenheit very largely stopped the trouble with the fir caps.

Treating Plants

The Sante Fe has built, in all, four treating plants. In 1885 a plant was opened at Las Vegas, N. M., and it burned down in 1908. In 1898 a plant was opened at Bellemont, Ariz., and this burned down in July, 1906. Both of these plants were designed for the zinc chloride treatment, although some creosoting was done. The buildings for these two plants were temporary wooden structures, in which fire hazard was high.

The present plant at Somerville, Texas, was opened in 1907 and the Albuquerque plant in 1908 or 1909. The buildings for these two plants are reinforced concrete, thus reducing the fire hazard to a low figure. Both of these plants were designed exclusively for creosoting. During the late war period and nearly two years thereafter ties were treated by the zinc chloride process, but all bridge timbers and piles were creosoted. The total output from the four treating plants above noted is as follows:

	Ties	Timber Board Feet	Piling Lin. Feet
Las Vegas	6,221,598	22,575,490	790,729
Bellemont	2,123,519	9,607,215	224,521
Albuquerque	7,346,245	20,067,932	512,580
Somerville	43,423,230	213,411,285	8,172,169
Total	59,114,592	265,661,922	9,699,999

Some 380,300 linear feet of the above piling was treated by the Rueping process at the Somerville plant in 1906 and 1907 but piles usually are treated by the full cell process and receive from 12 to 16 pounds of creosote to the cubic foot.

Track Ties

On the coast lines redwood and fir ties haye been used extensively. Since the Albuquerque plant has been in operation we have sent its output to the Albuquerque and Arizona Divisions, as well as lines east and south of Albuquerque.

Ties from Las Vegas and Bellemont plants were generally treated by the zinc chloride process, while creosote was used at Somerville and Albuquerque.

The Rueping process has been used as standard, some 5 pounds of creosote per cubic foot of timber being left in the tie. On our Eastern lines we have used a lot of creosoted oak ties.

We are getting an average life of more than sixteen years out of all our treated ties and about 60 per cent of them are loblolly pine (the above applies to lines east of Albuquerque). This long life may partly be due to instructions issued in 1910 *that all new ties going into the track must be plated.* I may say these instructions have been religiously followed. I do not think since that date there has been a solitary track tie put into service without tie plates.

Originally tie plates were from 4½ to 5 inches wide by about 6 inches long. Our first flat bottom plates were 6 inches wide by 8 inches long and the present standard plate is 7½ inches wide by 9 inches long. Our present plates cut into the tie at the outer end, showing that the loading is not properly placed. A new design will probably be made increasing the length of plate on the outside of the rail. The exact percentage of increase will depend on the weight of heavy rail that may be adopted.

A good many ties have been taken out of service, because of mechanical wear, when there were no indications of approaching decay.

Six or seven years ago adzing or dapping machines were installed at our treating plants. Just before going into treating cylinders all ties are dapped for the tie plates and bored for spikes. At this time the ties are sawed to exact lengths, a short section being taken from each end. A good many ties are culled after sawing as decay is uncovered which did not show before.

For the past year we have two of these adzing machines at Somerville and they have been run twenty-four hours a day, and with that we succeeded in dapping or adzing between 98 and 99 per cent of all the ties shipped out.

A great deal of creosoted Oregon fir timber and piling has been used on our coast lines. This material was treated in commercial plants in Oregon and Washington and delivered to the company, via water, at National City and San Francisco, Cal.

A good deal of treated timber has been used for the floors in ballast-deck bridges. When we figure interest on the excess cost of the ballast deck over the open deck structure and also the cost of maintenance we can show a very interesting saving from the use of the ballast-deck bridges.

An interesting feature of the ballast-deck bridge is the very low maintenance cost. When the track has been thoroughly bedded and properly lined and surfaced almost no further expenditure is required during the life of the track tie. We have bridges above 100 feet in length which we have run from three to seven years without receiving attention other than the lifting of a few joints at very rare intervals.

Some years ago I examined a couple of pile bridges on the Southern Pacific. One of them was about 30 feet high and perhaps 120 long. The piles were driven somewhere from 1885 to 1887. They had been adzed or hewn to six-sided figure. You recognize this adzing must have taken off pretty nearly all of the sap wood. In that bridge I only found two piles that were beginning to show a little decay and that was right at the ground surface and decay was a great deal like it is ordinarily in untreated piles. There was a Southern Pacific man with me there in 1910 or 1911—it might have been a little later that I examined them —and the creosote was in no place more than a half inch thick and in most of the places where I cut into it it was not above a quarter of an inch, but those piles had been there since 1887.

Another bridge where the piles were left natural, that is round, they were driven about the same time but a good many more replacements had been necessary. However, it was safe to state that the piles had been in service for more than twenty years.

Now let us look at the results. Before we commenced treating ties they would give anywhere from three to eight or nine years of service. We have doubled the life of the track ties and before another year has gone by I think we will be able to show that the life is increased three times. The last five-year record shows twenty years' prospective life for the track ties.

Besides the increase in the life of the track ties, there are our bridges. Even when we had good white oak for piles we seldom got more than from eight to twelve years of safe life. We had to spend from 5 to 50 cents a foot per month to maintain the bridges after a few years went by. Compare that now with our creosoted ballast deck bridges that have stood for years and years and then have not cost ten dollars on one hundred feet per year.

Discussion

C. M. TAYLOR: The theory of the proposition that you can use 25 pounds for marine treatment and cut it in half for land work has been knocked in the head because the 10 and 12 pounds used in the early days was not enough to permeate all of the sapwood regardless of whether the piles were steam seasoned or air seasoned. A lot of that early difficulty was due to our skimping the treatment rather than to any intention of not doing what we thought was a good job.

I want to ask Mr. Robinson whether the tops of all of the piles which are driven now are first coated with some preparation and then covered with a paper covering the same as you rebuilt the Beaumont Division?

MR. ROBINSON: They are supposed to be, yes, sir.

MR. TAYLOR: That proposition of not only coating the tops of the pile with creosote oil, several coats, but covering them with tar paper is to my mind one of the best points brought out in Mr. Robinson's paper.

The problem of using a 12-inch cap on a 16 and 18-inch butt creates a difficulty that he found from experience was bad. I do not think any of you realize what happens when you chamfer the edges of the pile off in order to make it look like a good job under a 12-inch cap. As I understand, Mr. Robinson says they do not chamfer.

MR. ROBINSON: We cut them square.

MR. TAYLOR: I first heard of that being used in a creosoted piling in a wharf built in Galveston in 1888. Those piles were used twice. The original pier was demolished and the piles were again used in wharf construction around Galveston.

There is another instance of where creosoted piles had been shaped similar to the ones that Mr. Robinson speaks of on the Santa Fe, those used in the Louisville & Nashville structure near Evansville, Ind., where some of the piles were shaped octagonal before being treated. The history of that bridge is one of the most wonderful specimens of preservative treatment. In the case of the Southern Pacific in some places only a quarter of an inch received treatment, yet that quarter of an inch in heartwood served thirty years' life.

The thing that most engineers have to learn more about in connection with timber in general is that sapwood is the deadly enemy to long life timber construction if used untreated. One of the members said this afternoon in the meeting that any construction lives only the life of the sapwood if the sapwood is not treated. It is not possible to depend on the heartwood if the sapwood is allowed to go untreated.

J. H. WATERMAN: The Santa Fe are pioneers in the treating game and they have done more to advance the interest of treating bridge material than any other railroad in this country and they should be commended for it.

Now about paint. I went out with one of our superintendents of bridges. After he had built a ballast deck pile bridge he painted it with fireproof paint. Before painting those piling we put every pound of creosote in them we could get in. After they were painted with fireproof paint we built a fire around one of the piling. We did not try to burn up the bridge, but we put a lot of chips and other material around and set fire to it and then sat down to see what happened. All of the chips and wood around the piling burned up, but the piling was all right.

Another thing I am glad the Santa Fe does, and I wish some other railroads would emphasize it as positively as Mr. Robinson did. I am happy to know that you treat your stringers. You claim that they lose probably 10 per cent on account of treatment. Some bridge engineers think that because the stringer is weakened we ought not to treat it, but how many years after an untreated stringer is put in a bridge does it depreciate 10 per cent in strength? Now, gentlemen, what is the factor of safety for a bridge? One to five? Now, if it only depreciates 10 per cent at the end of ten years, a treated stringer is just as good as it was the year you put it in, so I think that failure to treat stringers because you weaken the structure is wrong.

One other point: One of our superintendents of bridges said to me the other day: "Waterman, if we had not begun treating our piling in 1912 I do not believe I could have gotten men enough to rebuild the bridges." Untreated white oak piling you get today, if you can get eight years' life out of it you do pretty well. Mr. Robinson says three or may be four.

Men, you cannot afford to build a bridge unless you want to get over a washout or a fire unless you use treated material.

We got twenty thousand sticks of cypress piling in the yard last fall. It was whispered around that we could not treat it. A certain railroad, I am not going to mention the name, shipped to a commercial plant cypress piling and they said that they could not treat it. They tried two or three various charges and failed to get any penetration. They gave it up, shipped the piling out and drove it without treatment. I said: "I guess we are up against it. We have twenty thousand sticks and we cannot treat it." We arranged for two charges. We took the longest and biggest cypress piling we had—56 and 60 feet long. We did what a good many treating men say you have no business to do, we steamed that pile. We drew a good vacuum and we pumped in the cypress piling all the creosote we could get in. We thought may be we would get 10 or 12 pounds per cubic foot. We got in 22 pounds and a fraction. That is what you can do with cypress piling if you try to do it. I took one of the cypress piling 56 feet long, picked the biggest I could get and sawed it in two 16 feet from the butt. Our bridge engineer has that sample up in his office. We took a cross section of it an inch thick and found it was treated through and through.

You can treat most anything when you learn how. We think we know how to treat pine piling, red oak piling and cypress piling and we are learning a lot about treating fir.

G. A. HAGGANDER: I will tell about the C., B & Q. experience with treated bridge timber. We have a creosoted ballast deck built in 1904 with timber bought from a commercial plant. Not a stick of timber has been replaced in it in eighteen years.

White oak piling was used and continued until 1911 and 1912. The quality became poor and we treated them. The first piles were treated by the zinc chloride process. Two years later we began to treat red oak piling with zinc chloride. We began to have doubts as to whether that would be a success because in unloading piling and driving it we had a good many failures. The trouble seemed to be that the piling was bad when we treated it. We almost gave it up for a year, and then began working on the proposition of getting better timber to start with. After that, all timber was inspected when cut and loaded on the cars in the presence of the inspector, seasoned at the tie plant under the supervision of Mr. Waterman and that settled that part of the trouble. Since that we have had very good luck with the red oak piling.

About 1914 or 1915 we began creosoting with straight creosote. We continue that except when creosote is very hard to obtain. At the present time we are building quite a few ballast deck pile bridges. All the lumber is treated with creosote. We are using untreated stringers and treated ties and fenders. We are considering seriously the proposition of treating the stringers in open deck bridges. I do not know of any road that does that now. If any of you do, I would be glad to know about it. The main drawback so far is the fire risk. We naturally think there would be a great deal of danger from fire. It is possible by protecting the deck by galvanized iron, painting the deck in some way or having the stringers seasoned a year or so after the gas has escaped that we can have good results and minimize that fire risk.

I am glad Mr. Robinson emphasized the feature of workmanship in putting in the timber, painting of the cuts, etc. For two or three years after we started using creosoted timber I do not think we had instructions out regarding those features. We worked up a set of rules for handling the timber. The men handling the work do not realize the importance of it, for we are having that trouble now.

MR. I. L. SIMMONS: I can answer the question regarding open deck bridges with creosoted stringers. The Rock Island uses that type of construction over about one-half of its lines. We have 341,000 feet of timber bridges. Of that 341,000 about 30,000 is full ballasted deck structure; 155,000 approximately is creosoted timber throughout and the other 155,000 is creosoted piles, caps, sway braces, untreated stringers and zinc treated ties and guard rail.

As to the fireproofing and fire hazard, I will say that up to 1909 our average fire losses were approximately $7,000 per year in bridges. That was before we used creosoted material extensively. Since 1907, or this last year, the amount which we paid for structures was about eleven thousand dollars. Our trouble is not in structures that are completed. We have lost probably five or six thousand dollars worth of timber that was unloaded and left on the side of the track until we could put it in. That would catch fire from the grass or locomotives and would be burned up before we could do anything with it.

So far as fireproofing is concerned, we use a 6x8 tie—6x8, 9, and space them 13 inches. The ties are laid flat. That leaves 5 inches in between the ties.

In that we take a 2x4 and block on top of the ends so as to keep the gravel or rock from running out and cover all that bridge with rock. The rock must be coarse. You cannot put gravel on. You might in this territory, but you can't in the South, because it collects too much moisture. In order to withhold mechanical wear on the ties you have to have it fully tie-plated. We have been using that type of construction since 1914. Prior to that time we had fireproofed with gravel without the use of tie plates and I have seen ties that would have been in service not more than four years where not more than 3 inches of solid wood was left in the tie. We were using 8x8 at that time. The rail cut down through the tie. Gravel gets under and chews the tie up. It resulted in our having to practically re-deck all of the bridges on one of our branch lines and a great many bridges on the main line. I doubt if there is any greater fire hazard with a properly fireproofed top to your bridge with creosoted material than there is with untreated. At least it does not show up so on our road. We lose more material which is piled alongside of the track.

There is another feature which enters strongly into the use of creosoted structures. A few years ago we lost one or two pretty long bridges, right near town. We began to investigate that and the conclusion I reached was that a creosoted structure is not a safe proposition in a town or near a town. The reason was simply this: the town officials drive the hoboes out and they would go down under the bridge and set their fire and then go away and forget it and we would be burned out. Under one of the bridges that burned I found the remains of six fires that had been started. I feel where you are near a town or in an obscure place where the place is not plainly visible to a train man I am not strictly in favor of using creosoted structures. When a creosoted bridge catches fire it is very difficult to save it, but we do save something on untreated material once in a while.

On the long bridges we are adopting a method of filling. We fill a panel. We have bridges that are a mile long. We simply have filled in, divided that into three or four different bridges and filled in as a fire wall.

GEORGE E. REX: As my first job, Mr. Faulkner sent me out to determine why 1905 zinc treated ties were failing by the hundreds of thousands. I spent seven months on all parts of the system examining the failure of those zinc-treated ties that had been in track less than two years. In going over the Beaumont Division, where the failures were particularly bad, I came along one day to a bridge foreman just capping a bridge and as I came up to the gang that was working he had just pulled his auger out of a hole he had bored for a sway brace and more than a gallon of water came out of that hole. I had him saw me off a section of that piling which is now in the Topeka office and I got to Topeka and made a report that if this was the treatment we were putting into the ballast deck bridges we had better stop now.

Five years later when Mr. Robinson was called into the rapid construction of the Beaumont Division bridges we went back to the bridge and got a sample of one of the other piling. The original piling was all sound, of course. No decay up to that time. The sap wood was about one-third penetrated. The second piling we took out in 1912 has from three-eighths to an inch and a half penetration in the sap wood and then there is hollow wreath around the entire pile and a large portion of the heart is gone.

That was the case on all of the piling on the Beaumont Division and is the one reason why you have had so many failures in creosoted material. Mr. Robinson readily recognized the fact that the only good treatment provided for entire penetration of the sap wood. If you did not get the entire sap wood treated you were wasting your money and so naturally he joined with me in persuading our road to put in all of the creosote that the timber would take and they will probably get an average of forty years' life out of their creosoted ballast deck structures.

In these investigations we learned that treating was only a small part and unless the timber was sound and in condition to take full sap wood penetration you would not have a good job and we early learned that the exterior condition of the timber was no criterion of its interior. After this we started cutting every stick of piling before it was treated to see that it was sound, and we also knew, of course, that the same thing applied to our ties. It was out of the question, of course, to cut off the end of every tie when we were treating fifteen thousand a day unless we had some automatic device to do it. It was then that we started the development of the boring and adzing machine which contained a saw and stamp which cuts off the ends of every tie. We experimented with smaller devices at first. It took a long time to develop, but as early as 1912 we installed our first modern boring and adzing machine in the Somerville plant.

The next year we installed another one and both were operated by electricity. Those machines have been running continuously since 1912 and 1913, and as Mr. Robinson told you, since the first day of July, last year, 1921, they have bored an average of fifteen thousand ties a day.

Going back to the zinc treatment of ties, after examining several hundred thousand of these ties, you can imagine my disgust at zinc treatment. I thought I knew a lot about it after having spent seven months, and I was not hesitant in saying that zinc treatment was mighty poor stuff. We learned, however, years afterward, that it was not zinc treatment that gave us bad results, but it was the care or lack of care of those ties and the lack of care during treatment.

In 1912 I happened to be called to Newton and in going over a section of track just east of Newton I found in the first six miles every tie bearing a 1904 or 1905 dating nail and as we had adopted the experimental track, Mr. Cooper and I decided this would be a fine place to watch, make an experimental track. Those ties were put in "out of face" when the second track was built east of Newton. We took an inventory of this track and either Mr. Cooper or some of the men under have kept a careful record of that track ever since. The average life, as they are practically all out now, on those zinc treated ties in that six miles of track was fourteen and four-tenths years, in a country where the rainfall is more than 40 inches per year. These ties were treated at the same plant under the same supervision as the ties that I tell you about that came out by the one hundred thousand. Naturally we had a very great change of heart on the value of zinc treatment, and while it is generally assumed that zinc treatment leaches, personally, I have very little confidence in that statement or in that theory.

I have been interested in the studies of Mr. Bateman of the Forest Products Laboratory on the toxicity of the various preservatives and the reasons for the failures. None of these failures of treatment nor none of the successes of treatment are going to be any good unless the material is properly taken care of from the time the tie is cut off the stump until it is put into the track, and there is more timber lost between the tree and the proper preserving of it than is ever lost any other time. Those of you who have devoted your lives to the study of timber treatment and have taken care of the stick from the time it is cut, do not leave it, piled up in a wet place, do not let it be stacked on end, and you are getting magnificent results.

I want to say that the Santa Fe tie record to date cannot be beaten in the United States and I have a letter from their chief engineer within the week, stating on lines east of Albuquerque where Mr. Robinson said they are getting sixteen years—it is more than that—that only 10 per cent of those ties were hardwood and of the 90 per cent more than 65 per cent are loblolly. The only reason they are able to get that sort of record is because of the care and persistent effort they have made to take care of of that tie from the time it leaves the stump until it is put into the track and then through the track try to educate the men.

MR. HUMPHREY: I was very much interested in Mr. Rex's statements about cutting off the ends of the ties preliminary to treatment. I assume that most of these ties are southern pine. I was wondering about what proportion of these ties showed rot in advance of treatment and what type of rot was found in them. Is this a heart rot, so-called red rot of southern pine?

MR. REX: All sap rot.

MR. HUMPHREY: Do you discard ties on account of red rot?

MR. REX: Not entirely, depending on how far it is gone. As to the percentage, that depends upon the treatment the ties have received.

MR. ROBINSON: We have had, perhaps, one bridge a year burn out or partially burn out and the fires almost invariably caught from underneath. Very seldom the fire catches from above; never in ballast deck bridges and only once in a while in open decks. The expenditure on account of these fires is probably about the same as the Rock Island has had. As to the fireproof painting, that is a success if it is properly applied, but usually before the fire goes out the piling or timber is charred deep enough to go practically through the creosoting so that thereafter the pile is really wholly untreated.

My friend over here tells about the treating of the piles and the steaming. I have nothing to say about the steaming feature in the piles, but the stringers are what have to carry the heavy bending loads and we must not countenance the use of any treatment, I do not care what it is, that is going to reduce the strength of our stringers. It must not be done. The stringers have got every bit of work to do today that they can stand. We adopted about a year ago the E 65 loading. That is going to mean in open deck bridges a five-ply cord, 8x8 ties and longer caps than we have been using. We have either got to do that or go to steel stringers or what I am looking for and rather hoping for, to reinforced concrete bridges.

MR. EIKSEN: Do you bring the sway braces up to the cap?

MR. ROBINSON: We do. We carry a supply of creosoted blocks from 1 inch to 3 inches thick in order to fill out. Somebody said something about the 12-inch caps. In our latest model or plan for pile bridges where the stringers lap by on the caps, we get full bearing. On the ordinary open deck pile bridges, part of the stringers butt. We have no trouble getting sufficient bearing if the stringers are properly sized. A cap 12 inches wide is sufficient. We want them 14 inches deep to take the bending strength. The piles are sawed off horizontally. They are selected as to size so that the sway braces will draw properly, and then the tops are treated and covered with some kind of roofing and there is no trouble.

O. C. STEINMAYER: Regarding the air seasoning of timber and the general abandonment of the steaming of timber, especially in the Eastern states, it has been found for some time that steaming weakens timber, and further, that in the creosoting of the timber not as good penetration can be obtained as when the timber is air seasoned. For economic reasons timber is generally air seasoned in order to creosote.

Mr. Waterman asked me to give the experience of the Frisco Railroad in the treatment of cypress piling. The cypress that he refers to is not the all-heart cypress piling with which probably a good many bridge engineers are familiar. It is the cypress that grows in Southeast Missouri and Northeast Arkansas, known as white cypress, having a very big ring of sap wood. The Frisco Railroad during the year 1921 treated or had treated at its plant some eight thousand sticks with 15 pounds of oil per cubic foot of timber. We have gotten complete penetration of the sap wood and we have gotten a little penetration of the heart wood.

THURSDAY MORNING SESSION

January 26, 1922

The meeting was called to order by the President, Mr. Taylor, at nine o'clock a. m.

THE PRESIDENT: The first report this morning will be the report of Subcommittee 5-1-1, on Ties, Fir, by R. H. Rawson.

THE SECRETARY: No report.

THE PRESIDENT: There is no report at this time from the Fir Tie Committee. Are there any comments that should be made in connection therewith? If I understand it properly one of the developments of the fir tie problem during the year is that one of the large Canadian roads is thinking very seriously of putting in a machine that not only incises, but punctures or needles all ties before they are treated, which is a healthy development from the work of the Committee.

The next committee report will be that of Subcommittee 5-2, Lumber, Car.

Chairman Smith is not here, and Mr. Barth will present the report.

REPORT OF COMMITTEE NO. 5-2—CAR LUMBER

To the Members of the American Wood-Preservers' Association:

This Committee has spent several years studying the subject of treatment of car lumber and about the only definite fact that it has been able to establish is that a large portion of freight car failures is due to decay.

Since decay is responsible for more repairs to wooden cars than any other single factor it follows that a way must be found to prevent decay without retarding the work of shop forces engaged in repairing the cars.

All will agree that the pressure treatment is superior to other known methods of preserving wood and that creosote is the best agency by which its physical life may be extended. Zinc chloride and sodium fluoride are also proven wood preservatives of high rank, but to be of any material value they must be applied under pressure, while the application of creosote by means other than pressure, such as non-pressure treatments, will unquestionably add to the life of the timber so treated.

Considerable time has been spent by the individual members of this Committee in studying the manner in which the work of repairing cars is conducted at various railroad shops, and every conceivable method of treating car timbers by the pressure process after they have been framed, has been discussed and discarded as impracticable. In most cases treating plants are located many miles from the car shops, meaning that after the timbers have been framed they must be loaded on cars and sent to the plant for treatment, and if framed for any particular cars they would have to be held in the shops pending receipt of the treated timbers from the treating plant. It would also mean carrying a large stock of standard framed car timbers in stock at the treating plant and continual rush calls for specially framed timbers that may or may not be available at the plant.

There is also the usual objection to the use of creosoted timbers that is always met with account of refusal of labor, especially the semi-skilled labor, usually employed around car shops, to handle these timbers after they have been treated. However, this feature could be overcome by the use of zinc chloride or sodium fluoride, which are not offensive to handle, and if it were practical to apply either of these preservatives without pressure our problems would be nearer solution.

This Committee earnestly desires to see some definite step taken toward preserving car lumber and recommends the very simple method of giving all points of contact a brush treatment, using two brush coats of hot creosote. This should also apply to roofing and in the case of open and stock cars to the decking, posts and entire interior of the car. A very high grade creosote oil should be used to secure the maximum penetration, but the specifications should, it is felt, be prepared by the Committee on Preservatives.

This treatment should be applied to all points of contact regardless of whether the timber is green or dry, or whether it is white oak, red oak, pine, fir, or any other species. We know that best results will be obtained if the timber is dry, but it is not always dry when put in a car and we must face the conditions as they actually exist. It is certainly better to paint creosote on a green piece of timber than to put none on it at all, and this principle if accepted, must be general and cover all lumber used in freight car construction and maintenance.

It has been suggested that the actual application of the creosote be supervised by the Department of Timber Preservation of the railroad, and this would without a doubt be the ideal arrangement if the Mechanical Department would lend its full support to the movement.

It is recommended that the Service Bureau lay this matter before several of the larger railroads with a view of having them begin the treatment of their car lumber as outlined above and a committee assigned to watch the progress of this work and report at the next meeting of the Association. As the benefits of this brush treatment become apparent, improvements will of course be made in the manner of doing the work and they should be carefully noted by the committee and included in its report.

W. J. SMITH, *Chairman.*
K. C. BARTH.
R. C. CLARKE.
E. E. INGALLS.
C. E. PAUL.

MR. BARTH: Mr. President, I would like to add a few personal remarks to this report. I have been an interested member of the Committees on this subject for several years, and those who have read all of the previous reports of these Committees will realize the difficulty they have had in securing the cooperation of the men connected with the car departments of the various railroads. To me this report is unsatisfactory, although as a member of the committee, I am as much responsible for it as anybody else. This situation is largely due to the fact that we really have not had the facilities to go into this matter as thoroughly as we should. I was not in the room yesterday afternoon, but I heard there was discussion on this subject by those present on this subject. Whatever committee undertakes this investigation next year must have more support, more actual cooperation from railroads, from the men on the railroads that are responsible for this kind of work, than we have had in the past.

As I view the situation, there are three problems involved, (1) the cars that are repaired in the repair shops of railroads, (2) cars that are built under contract in commercial car shops, and (3) cars that are built in the railroad shops. Any treated material that is used in these cars, the application of it, must conform to existing shop conditions. I know of railroads that use pressure treated material in cars built in their own shops, and at the same time they cannot apply materials so treated in cars built outside under contract, because the facilities therefore do not yet exist. I know of railroads that can put pressure treated material into cars built by themselves at certain of their shops, but who can't apply pressure treated material to cars being repaired at their widely distributed repair yards. So, there are these conditions that must be met, and if any treatment that can be applied will retard the development of decay, will retard the huge destruction of car material, it is worth while. He have some records that prove that this can be done. However, it is largely a matter of evolution. We have to take one step at a time, and when we have *sold* the railroad officials on the necessity of using treated material in their cars, we can induce them to improve their methods.

THE PRESIDENT: Gentlemen, this topic is now open for discussion. We would ask that your discussion be short and to the point. There is a big field for work in solving this problem.

MR. ANGIER: Mr. President, I move that this report be accepted as information. We are appointing a committee this year to go into this very thoroughly. I think this committee should be composed of railroad men, who, as Mr. Barth says, have access to the shops, and can go into the matter of treating all kinds of car material. This report states that every conceivable method of treating car timbers by the pressure process after they have been framed has been discussed and discarded as impracticable. I presume that means after the timber has been framed and put in place. Of course, in that case it could not be treated with the pressure process, but the timber could be framed and treated before it is put in place. I think that is what we will have to do, to get our timbers ready to put in the car and then treat them. I hope that we can find a way of treating all car material that fails from decay.

THE PRESIDENT: Is there a second to Mr. Angier's motion?

MR. VON LEER: I second the motion.

THE PRESIDENT: It is moved and seconded that the report of the Committee be accepted as information. Are there any other remarks? Is it the intent of our Committee to ask the cooperation of the Master Car Builders?

MR. BARTH: We have to.

THE PRESIDENT: Remember they are our best friends in this proposition. I hope in the appointment of this Committee that fact will be taken into consideration.

MR. BARTH: Regarding cooperation with the Master Car Builders' Association; I remember very distinctly three years ago when we did have a joint meeting with the Committee that I was on at the time and the committee on car construction of the Master Car Builders' Association. We were politely told by the chairman of that committee that they had absolutely no interest in the preservation of timber for freight cars, because very shortly wood would be eliminated from freight cars. I think that the last year has seen a change in that respect, but that is the general feeling of the people who have been in charge of the designing and standardization of freight cars in the American Railway Association. There are a few who have expressed themselves as opposed to that attitude, but the Master Car Builders' Association has so far refused to take cognizance of this subject officially or unofficially.

THE PRESIDENT: I repeat we still need them as our friends. Are there any other remarks in connection with this motion? If not, all in favor of the motion as put by Mr. Angier please say "aye;" opposed, a like sign. It is so ordered, and the Committee is thanked for their efforts.

The next paper will be on "Creosoted Wood Stave Pipe," by Mr. H. D. Coale, who is Chief Engineer of the Continental Pipe Manufacturing Company, one of the largest producers of wood pipe and culvert and flume stock in the West. In the absence of Mr. Coale, Mr. Horrocks will present the paper.

MR. HORROCKS: Mr. Coale was unable to come east; in fact, when I left he was in the hospital, very seriously ill. But I think probably he is on his feet by this time. He had promised to write a paper on this subject, and by a desperate effort he accomplished the job just before he went to the hospital. The paper is as follows:

WOOD PIPE AND THE CREOSOTING PROCESS

H. D. Coale

Chief Engineer, Continental Pipe Manufacturing Company

Notwithstanding the activities of a thoroughly capable Wood Pipe Publicity Bureau, it is more than likely that many thousands of people in this country are not aware of the existence of wood pipe, and possibly some of those gentlemen present will be surprised to know that millions of people in this country and a great many in other countries obtain all of their drinking water through wood pipe.

We will not mention the old form of wood pipe consisting of bored out logs that were in use centuries ago, for such construction would not be adequate for present day requirements.

The modern wood pipe of today is made for low pressures or high and to suit all the different cases requiring the transportation of water whether for city water systems, irrigation systems, power plants, or numerous more minor uses. Its manufacture is simple to the uninitiated but difficulties are encountered in actual practice. The staves have to be of a proper quality and of proper dryness, the banding must be accurate and the tension applied, in wrapping the wire, such as to give the ultimate results desired.

When the modern wood pipe was developed there was little to look back on as an aid to getting immediately the best results in wood pipe construction. It was assumed that staves saturated at all times, would be immune from rot and that wooden collars adjoining the ends of the pipe sections would receive sufficient saturation to preserve them also. Time has shown that in a large percentage of instances the staves of the pipe proper have been preserved and this has been especially true where the soil conditions have been favorable, but the wood collars have never developed a life equal to the staves and therefore the use of the wood collar creosoted by the vacuum and pressure process has been a great blessing to those in the wood pipe business, as well as others who use it.

Possibly the records of the association go back a considerable number of years in showing examples of the efficiency of the creosote treatment.

Examples of wood pipe that is treated are more rare and may be enumerated as follows:

In about 1895 the Southern Pacific Railway Company placed across their main line tracks in southern Oregon a considerable number of creosoted wood stave culverts. These we have been able to ascertain are treated by the pressure process, but the character of the oil and the method of treatment is not of course known to us. These have been inspected recently and the wood is apparently as good today as new wood. These culverts have endured treatment that is most detrimental to the life of any untreated wood structure.

In 1902 a 12-inch pipe 1000 feet in length was erected in the City of Everett, Washington, as a conveyor of water to a condensing plant. This pipe during the last five years has been used merely at intervals and during this period the conditions to which the pipe have been exposed would be considered deplorable were the pipe untreated. The pipe line today is to all intents and purposes as good as when it was laid 19 years ago, and in the words of the Water Superintendent of Seattle, "Looks good for another twenty years."

Twelve hundred feet of 50-inch pipe was erected for the Burbank Irrigation District in 1912. Although subjected to periods of alternate wetness and dryness, partly covered and completely covered, this pipe when subjected to recent test was found entirely free from any deterioration whatever. The more recent of the important pipe lines consist of a 2-mile line of 12-foot pipe at Potsdam, New York, 2 miles of 4-foot pipe installed for the Indian Service near Wapto, Washington, and nine thousand feet of 63-inch pipe installed by the Wenatchee Irrigation District in 1916. These are all in perfect condition.

Creosoted pipe of smaller diameters has been installed in the last three years consisting of many thousands of feet for irrigation purposes and to a certain extent for domestic water supply.

The taste of the water after being carried through wood pipe is a very important consideration and has not been overlooked in careful investigation. Probably the duration of the taste, which naturally occurs, will not exceed that of new cast-iron pipe under equal conditions.

The strength of creosoted staves is an important feature and without further comment we reproduce a series of tests made at the Engineering Laboratories of the University of Washington.

TABLE 1.—BAND BEARING TEST ON DOUGLAS FIR STAVES

Staves soaked in water one month before test

Condition of Stave	Load in pounds required to press a section 3.35 inches long of various diameter bands into the stave to a bearing of 60 and 90 degrees of arc.								
	0.198		0.226		0.497		0.625		Ave. for all tests.
	60°	90°	60°	90°	60°	90°	60°	90°	
Staves containing sapwood.									
Natural.....	166	371	218	453	507	1096	608	1334	594
Treated.....	171	414	250	518	620	1338	756	1663	716
Treated in per cent of natural...	103.1	116.6	114.7	114.4	122.3	122.1	124.4	124.7	120.5
Staves all heartwood									
Natural.....	196	460	267	574	592	1291	714	1572	708
Treated.....	210	531	332	713	752	1596	880	1929	868
Treated in per cent of natural...	107.1	115.5	124.4	124.2	127.0	123.6	123.2	122.7	122.6

The conclusions drawn by the experiments are contained in the following:

These tables show that the resistance to band pressure of the treated staves is slightly in excess of that of the untreated or natural stave. A comparison of the values given for the treated sapwood staves with the values given for the untreated heartwood staves discloses the fact that the average of the eight tests of these two kinds of staves gives the treated sapwood stave a value slightly in excess of the untreated heartwood stave.

Other conclusions drawn from the tests are:

1. Sapwood should not be considered a defect in Douglas fir staves to be creosoted.
2. The creosote treatment as given does NOT injure the strength of heartwood or sapwood.
3. Sapwood has sufficient strength both before and after treatment to readily withstand band pressure.
4. In every case the sapwood was completely penetrated by the creosote oil.

Since the introduction of the use of creosote into wood pipe practice many engineers have discriminated very carefully as to when untreated staves or creosoted staves may economically be used. A comparison in cost of iron and steel pipe with wood pipe usually shows the wood pipe much lower than the cast iron and in many instances lower than steel. Believing, as we do, in the efficiency of the creosoting process as now used, we do not question the superior value of wood pipe in comparison with steel regardless of price.

In comparison with cast iron pipe there are many thousands of installations where wood pipe could have been used with vastly greater economic results.

In this connection it should not be overlooked that wood pipe new and old is practically the same in diameter. There is no decrease with age owing to its tuberculation, etc.

The writer regrets that he is not present at this meeting to respond to such inquiries as may arise and trusts that there will be an argument that will be beneficial to the wood pipe business and to the wood preserving business as well.

THE PRESIDENT: This paper is now open for discussion. Mr. Horrocks will be glad to answer any questions that might have been addressed to Mr. Coale.

MR. HORROCKS: I will add to what Mr. Coale has had to say regarding the contamination of water going through creosoted wood pipe, that at our plant, in our community, we are drinking water that is stored in and distributed out of a creosoted Douglas fir tank, and nobody has ever mentioned any contamination or odor or taste. We are feeding water into our boilers that is stored in a creosoted Douglas fir wood tank, and our boilers are doing well.

THE PRESIDENT: Are there any other remarks?

MR. DEBERARD: May I ask for a little information as to the definiteness of the tests that were made on the water conveyed through these creosoted pipes.

MR. HORROCKS: These were tests made at the University of Washington, the idea at that time being to, in miniature, arrange a test that would be comparable with conditions in the pipe lines from Cedar River bringing water into Seattle. The details are not given here but these tests were under the direction of some scientific department in the University of Washington and were conducted for a sufficient period of time to in their judgment prove or disprove contamination or pollution of water that flowed through this creosoted pipe. Their report was favorable.

Further than that the pipe line that is mentioned as having been installed at Wenatchee, Washington, primarily for irrigation purposes, as is nearly always the case in irrigation districts, carries water used for domestic purposes from the same source. The line was installed. They had to hurry construction as much as possible in order to have water for irrigation at the beginning of the irrigation season. There was practically no time for washing out the line or paying attention to that feature, and it was quite noteworthy that there were no complaints on the part of the people who were using that water for domestic purposes. The proposition is just this, that in the treatment of these staves one of the primary considerations is the exhaustion to the fullest extent possible of free oil. I have rubbed my hands over creosoted staves and I scarcely soiled them.

THE PRESIDENT: If the Association has finished its discussion on this subject we will be glad to hear the report of the Committee on Wood Pipe, Subcommittee 5-6.

MR. HORROCKS: The President appointed a committee consisting Clyde Osborne, Mr. H. D. Coale, and myself, with instructions to draft a specification for the creosote treatment of Douglas fir wood pipe staves, and the result of our efforts is as follows:

REPORT OF COMMITTEE NO. 5-6—SPECIFICATIONS FOR CREOSOTE TREATMENT OF DOUGLAS FIR WOOD PIPE STAVES

To the Members of the American Wood-Preservers' Association:

Drying and Manufacturing Staves

(1) Lumber from which pipe staves are to be machined shall have been either air or kiln dried in the rough until the moisture content, compared with oven weight, has been reduced to no more than 20 per cent. Lumber shall then be machined to size of pipe for which intended. As quickly as possible after machining staves

shall be transported to point of treatment and all possible care shall be used to protect staves from the elements during such transportation.

Treatment

(2) In loading staves on treating trams they shall be either loosely stacked or separated with lath in such manner as to allow free circulation of creosote around the stave and to provide for drip and drainage of free creosote into the treating retort. They shall always be loaded either with the convex surface upward or on edge. Sharp tools and wire rope slings must not be used in handling staves and care must be used at all times to protect edges of staves from injury.

(3) Staves shall be treated by the Boiling Under Vacuum—Empty Cell Process. The temperature of creosote shall at no time exceed 190 degrees F., under a vacuum of at least 20 inches mercury; except, where the staves, when ready for treatment, show moisture content in excess of 20 per cent, as compared with oven dry weight, a temperature not exceeding 200 degrees F., under a vacuum of at least 20 inches mercury, may be used for such time as may be necessary to reduce the moisture content to required minimum.

(4) Staves shall be held in the hot creosote sufficient time to thoroughly warm the timber and shall then be subjected to air pressure of such intensity (not exceeding 100 pounds per square inch) and duration as will well permeate the wood. Creosote shall then be pumped into the wood without releasing the preceding air pressure under such intensity (not exceeding a maximum of 150 pounds per square inch) and in such quantity as will insure the final retention of the specified pounds of creosote per cubic foot.

(5) Following release of pressure, the temperature shall be raised to a maximum not exceeding 210 degrees F., and held for approximately one-half hour for purpose of expanding the air and creosote contained in the wood. The creosote shall then be quickly exhausted from retort and a vacuum of not less than 20 inches mercury drawn on retort for such period of time as may be necessary to insure withdrawal of free creosote from and cooling of the wood. The charge is then in condition for withdrawal from the retort.

Creosote

(6) The creosote used shall be a distillate of coal-gas coal tar or coke-oven coal tar with no admixture of pitch, undistilled tar or products of petroleum origin. It shall comply with the require-

ments of specifications of the American Wood Preservers' Association covering creosote oil for ties and structural timber, and any changes that may hereafter be made in same. The present specification reads as follows:

(a) It shall not contain more than 3 per cent of water.
(b) It shall not contain more than 0.5 per cent of matter insoluble in benzol.
(c) The specific gravity of the oil at 38 degrees compared with water at 15.5 degrees C., shall not be less than 1.03.
(d) The distillate, based on water-free oil, shall be within the following limits:
  Up to 210 degrees C., not more than 5 per cent.
  Up to 235 degrees C., not more than 25 per cent.
(e) The specific gravity of the fraction between 235° and 315° C. shall not be less than 1.03 at 38° C. compared with water at 15.5° C. The specific gravity of the traction between 315° and 355° C. shall not be less than 1.10 at 38° C. compared with water at 15.5° C.
(f) The residue above 355° C., if it exceeds 5 per cent shall have a float-test of not more than 50 seconds at 70° C.
(g) The oil shall yield not more than 2 per cent coke residue.
(h) The foregoing tests shall be made in accordance with the standard methods of the American Wood Preservers' Association.
  Care must be used that only clean, liquid creosote, satisfying the above requirements, is used in treatment of wood staves.

Condition of Finished Product

(7) The finished staves shall show, by the above process, eight pounds of creosote per cubic foot; they shall be free from injurious seasoning checks; they shall have been exhausted to the fullest extent possible of free creosote; they shall be free from adhering muck, sediment or other foreign matter; they shall not be warped, twisted, buckled nor so distorted as to be unserviceable in pipe for which intended; and shall be free from abrasions or other injury due to handling.

General

The treating plant shall be properly equipped with accurate instruments for at any time determining temperatures and pressures used. It shall have proper facilities for testing of creosote. It shall, during business hours, grant the free use of such facilities to purchasers' representatives if desired.

H. E. HORROCKS, *Chairman*
H. D. COALE
CLYDE W. OSBORNE

THE PRESIDENT: Gentlemen, you have heard the report of this Committee. It is now open for discussion. I can say that this is one committee that got their report in on time so that it could be distributed to the members fifteen days prior to this meeting. After we have discussed this report it will be before the convention for voting as to whether it shall be submitted to letter ballot of the Association.

MR. BERGER: The specifications as submitted by this Committee are quite satisfactory to us. They have our approval, but if it is in order I believe one of the conclusions which Mr. Coale arrived at, in fact, the first one, that sapwood should not be considered a defect in Douglas fir, should be embodied in this report.

THE PRESIDENT: As I understand, Mr. Berger, that can hardly be included in the specification for treatment.

MR. HORROCKS: I think that would probably be correct. That would be a question in regard to the buying of the lumber and also the selling of the pipe, but it really has nothing to do with the creosoting of it, I believe. We are all with you on the correctness of that, and we will help you put it over.

THE PRESIDENT: Mr. Berger's point is well taken. The thing we all want to think about is that treated sap is just as good as all heart, in fact, much better, in many instances; but I do not believe we wish to enter the field of lumber specifications when our problems are those of treatment.

MR. HORROCKS: Mr. President, it would be rather unusual to suggest a modification of my own work, but it has occurred to me that there is one place here where the Committee is in error. We fix the poundage of creosote at 8 pounds per cubic foot. Now you can put in more than 8 pounds, and you can leave more than 8 pounds in these staves, and there may be particular uses where more than 8 pounds would be desirable. We might modify that specification in that particular to make it more flexible. I would move that the specification be altered in Paragraph 7 to read: The finished staves shall show by the above process the required poundage of creosote per cubic foot."

THE PRESIDENT: Is there a second to that motion?

MR. HOSFORD: Why not just leave it blank for insertion?

MR. HORROCKS: I will accept the modification. That puts it in better shape.

MR. HOSFORD: Then I second the motion.

THE PRESIDENT: It is moved and seconded that the clause in Section 7 the pounds required per cubic foot be left blank so that it will read: "The finished stave shall show by the above process .. pounds of creosote per cubic foot." Are there any objections to that correction in the specifications? All in favor please say "aye;" opposed "no." The motion is carried.

Are you ready for a motion on the whole specification?

MR. HORROCKS: I move, Mr. President, that the specification be submitted to letter ballot.

The motion was seconded.

THE PRESIDENT: It is moved and seconded that this specification which was distributed fifteen days prior to the annual meeting be submitted to letter ballot of the Association. Are there any remarks? All in favor of that motion please say "aye;" opposed, a like sign. It is so ordered, and the Committee is excused with our thanks.

The next subject is poles. We have two Subcommittees, one on pressure treatment, and the other on non-pressure treatment. Mr. Hosford is general chairman of both, and both Subcommittees will come forward at this time.

MR. HOSFORD: Mr. President and members of the American Wood-Preservers' Association, Committee 5–5–1 on Pressure Treatments had assigned to it three subjects for this year; (1) to continue the work of getting the history and arranging for the inspection of representative lines of pressure-treated poles; (2) to report on the possibilities of puncturing as related to pressure treatment; and (3) to draft specifications for pole treatment. As you will see from the report which has been printed, and which I think has reached all of you, considerable work was done in expanding and adding to the number of cases where information can in the future be gotten as to the results obtained with different kinds of pole treatment. The list is given in the first and second pages of the report, and some information about a number of sections selected, which I think it is unnecessary to read.

REPORT OF COMMITTEE NO. 5-5-1—PRESSURE TREATMENTS

To the Members of the American Wood-Preservers' Association:

Following the lines suggested by the preceding Committee, we beg to offer this report:

The following lines of creosoted poles (full-cell treatment) were observed by the Committee prior to last year's report:

1. American Telephone and Telegraph Company, Washington-Norfolk Line.
2. American Telephone and Telegraph Company, Montgomery–New Orleans Line.
3. American Telephone and Telegraph Company, Birmingham–New Orleans Line.
4. American Telephone and Telegraph Company, Charleston-Montgomery Line.

Further information on these lines should be available during 1922. Inspections of No. 2 and No. 3 were made this year, and inspection of No. 1—partly made this fall—should be completed in the spring of 1922.

The following new full-cell lines are listed for examination as opportunity offers:

5. Southwestern Telegraph and Telephone Company, Dallas-Gulf-Sherman Line.
6. Gulf-Pipe Line.
7. Galveston-Houston Line.

The following empty-cell lines have been listed for examination and report as opportunity offers:

8. Texas Power and Light Company, Wichita Falls, Texas, to Burkburnett.
9. Texas Power and Light Company, Wagner City to Burkburnett.
10. Houston Lighting and Power Company, Houston, Market St. Power Station to the Ship Canal.
11. Kansas City Light and Power Company, Olathe to Kansas City, Missouri.
12. Orleans-Kenner Line, New Orleans.

The data on Item 8 is as follows: The line was built in July 1919; it runs from American Refining Junction, Wichita Falls, Texas, to Burkburnett Sub-station, a distance of 15 miles. The poles were longleaf yellow pine, 42 feet long, 7-inch top, air seasoned; furnished by the Long-Bell Lumber Company under their specification for creosoted yellow pine poles. They were treated by the Lowry process, with an initial injection of 16 pounds and a retention of 8 pounds; the oil was in accordance with the A. W. P. A. Specification for Grade 2 oil.

Item 9 was built a few months later than Item 8; it runs from Wagner City to Burkburnett, 5.3 miles; the poles and treatments were the same as in Item 8.

Item 10 is a transmission line of the Houston Lighting and Power Company; built in 1917; runs from their power station on Market St. to the North side of the Ship Channel; it contains 225 longleaf yellow pine poles, 35 feet long, 8-inch tops, air seasoned. They were furnished on the same specification as that used in 8 and 9; the treatments were the same.

Item 11 is a line of the Kansas City Light and Power Company, built in 1919, between Olathe and Kansas City; contains about 400 poles, longleaf yellow pine, 35 feet long, 7-inch tops; pole specification and treatments the same as on 8, 9 and 10.

Item 12 is a line of the Orleans-Kenner Electric Company, of New Orleans; it runs from New Orleans to Kenner, Louisiana, and was built in 1915; it contains 1000 yellow pine poles, 32 feet long, with 7-inch tops. The poles were treated with the empty-cell process; steamed 9 to 10 hours, according to the condition of the timber, at a temperature of approximately 280° F.; a vacuum of about 20 inches was drawn and held for 3 hours; air pressure of 60 pounds was used, 1 hour being required to reach that pressure; oil was then admitted to the cylinder, the air pressure varying from 100 to 125 pounds, usually the latter; maximum injecion of oil 15 to 16 pounds and retention from 7 to 8 pounds; the records indicate that the oil was an English distillate with a specific gravity of about 1.04.

The Committee has had considerable discussion of the subject of perforation of poles in relation to pressure treatments but has not found it practicable yet to formulate definite ideas.

Tentative specifications have been drafted for pressure treatment of poles by full-cell and empty-cell methods, but these matters have not yet been worked out to a conclusion.

The Committee has secured some information on the treatment of poles by the Rueping process in England and in Denmark and hopes to find it possible in the course of time to get similar information from Germany.

Suggested Program of Work for Next Year

The Committee recommends the following:

1. Clarify and extend its examination of the life histories of full-cell process pole lines.
2. Start the examination of the life histories of empty-cell process pole lines.
3. Ascertain if the perforation process has been used in pressure-treated poles and, if so, with what result.
4. Study the theory of perforation in the preparation of pressure-treated poles.
5. Develop a specification for treating poles by the full-cell process.
6. Develop a specification for treating poles by the empty-cell process.
7. Collect data on the use and results of the empty-cell treatment of poles in Europe.

W. M. CARPENTER, *Chairman*
C. D. BATSON
E. E. BOEHNE
R. C. EGGLESTON
C. C. FRITZ
A. H. VORUM

ROGER F. HOSFORD, *General Chairman*

MR. HOSFORD: I had hoped that they might at least have reached the stage where they could be printed, and appear for discussion during the next year, but that was not possible. The Committee also has secured considerable information on methods and some on results with treated poles in several countries abroad. It still has lines out to secure more of that information. The recommendations for next year's work are as listed at the end of the report.

THE PRESIDENT: Gentlemen, you have heard the Subcommittee's report on Pressure Treatment. Are there any comments at this time?

MR. LARKIN: Mr. President, there is no doubt that this Association is realizing more all the time the importance of this branch of the wood-preserving industry, and it seems as though emphasis should be given to this work and that as complete a discussion given to the report as possible, especially by those interested in the dipping process.

MR. GOLTRA: I notice the statement that 15 to 16 pounds of oil were injected into the poles and 7 or 8 pounds per cubic foot were left in the wood, which would indicate that 8 pounds of oil were withdrawn. I am curious to know by what process that was accomplished. How is it possible to inject 16 pounds of oil per cubic foot of timber and withdraw half of it?

MR. HOSFORD: I think I will let Mr. Fritz answer that.

MR. FRITZ: I did not know that this particular treatment was mentioned in the report.

MR. HOSFORD: Mr. Batson, who is not here, prepared that part of the report. Mr. Larkin, perhaps you could speak for him. That, I think, was one of the Mobile jobs.

MR. LARKIN: I don't know anything about Mr. Batson's work or the work he has done on that committee, but as far as Mr. Goltra's question is concerned we know that the empty cell process makes it possible to inject a certain amount of oil and then withdraw practically half of it with the help of the initial air pressure, and then the subsequent vacuum.

THE PRESIDENT: Is that satisfactory, Mr. Goltra?

MR. GOLTRA: I do not believe it is possible by any process to recover such a large proportion of the oil injected into the wood. This process of putting on an initial pressure and subsequent vacuum is neither the Lowry nor the Rueping process, and by neither one of those processes can you recover as much as that. I admit you can recover a part, the kick back probably is one-fourth of what is injected, but not any such quantity as one-half of that quantity injected into the wood.

MR. HOSFORD: I think all the Committee can say at this time is that all of these statements as to methods of treatment that are presented in this way are collated from the records that are obtained either by the treating plant or by the consumer who receives the poles, as to what happened in the treatment. In this particular case the member who prepared the matter is not here to speak on it. If desired, I have no doubt that he can present a written discussion of that point for Mr. Goltra.

THE PRESIDENT: In case he can't, I can. It is possible to put in 16 pounds of oil under certain conditions and get half of that back. Are there any other remarks in connection with this report?

MR. LARKIN: Mr. President, I know that this Committee has done a lot of work in connection with this subject and I think the members here would appreciate it very much if perhaps Mr. Hosford would give us something with reference to the relative possibility of treating sap wood and heart wood. Is it possible to treat with this process any of the heart timber?

MR. HOSFORD: Well do you mean this process that Mr. Goltra is asking about?

MR. LARKIN: No, the regular open tank method.

THE PRESIDENT: We are not on the open tank. We are still on the pressure report.

MR. LARKIN: Then I will hold my question.

THE PRESIDENT: All right. Are there any other remarks on the pressure pole treatment?

MR. HOSFORD: I move that the report be accepted as information.

MR. STEINMAYER: I second the motion.

THE PRESIDENT: It is moved and seconded that the report of Committee 5-5-1 on Pressure Treatment be accepted as information, and that their recommendation for future work be considered by the program committee. All in favor of that motion please say "aye"; opposed a like sign. It is so ordered.

The next report will be on non-pressure treatment.

MR. HOSFORD: The report of Committee 5-5-2 last year recommended for consideration about ten separate problems, of which six were assigned to be worked upon this year. The first problem was to make computations of the probable loss of strength due to different spacing and depth of punctures.

REPORT OF COMMITTEE NO. 5-5-2—NON PRESSURE TREATMENT OF POLES

To the Members of the American Wood Preservers' Association:

In conducting its work during the past year your Committee took the recommendations given at the end of the 1921 Committee report and endeavored to obtain as much information as practicable on each point. These recommendations are listed below together with a brief statement of the progress which has been made in each case. Following these statements there will be found various exhibits which give supporting evidence.

1. *Make computations of the probable loss of strength due to different spacing and depth of perforations and different sized poles.*

This question was taken up with the engineers of the Forest Products Laboratory, who stated that the theoretical loss in strength would be a function of the depth of the holes and the maximum percentage of the circumference cut in a horizontal plane. From this it will be seen that a most important factor is the percentage of circumference which is cut. It is to be expected, therefore, that a perforating pattern which experience shows will give the desired depth and uniformity of penetration with the smallest possible proportion of circumference cut will cause the least reduction in strength.

Just how closely the actual loss in strength will approximate the theoretical loss cannot be stated, because there are so many factors which will influence the result and whose effect cannot be determined without extensive tests.

It is the opinion of your Committee that while it is, of course, desirable that the loss in strength due to perforating shall be as little as possible, the value of the perforations in insuring a deep and uniform penetration around the whole circumference of the pole is of greater importance and will more than offset any reduction in strength.

2. *Make strength tests to see how the actual strength losses compare with computed losses.*

It is felt by the Committee that strength tests would be useless unless carried out on a sufficient scale to give conclusive results. It has been estimated that to make such tests to show the relative strength of perforated and unperforated poles immediately after perforating, using but one type of perforating point and but one spacing pattern, would probably cost in the neighborhood of $1,000, exclusive of the cost of poles and freight to testing point.

To go into the subject more thoroughly and determine the relative strength of perforated and unperforated poles after they have reached equilibrium under service conditions and to determine the effect of such factors as the moisture content, depth and spacing of perforations, shape of perforating instrument and the species, would probably cost $10,000 to $15,000 and require a total elapsed time of several years.

In the opinion of the Committee the exact loss in strength due to perforating is not a matter of sufficient importance to justify such tests. The principal value would be to point the way to improvements in the perforating process and the direction of improvement has already been determined in the recognition of the principle that the reduction in strength is dependent upon the percentage of the circumference cut in a horizontal plane.

3. *Determine the effect of the perforations upon checking.*

Considerable work on this subject has been done by Mr. J. D. Burnes at the Page and Hill Company's plant, but the period of observation has been insufficient to justify the forming of conclusions, and the Committee recommends that this subject be continued by the 1922 Committee.

4. *How much does oil spread from the perforations after treatment? Is there an appreciable difference between completeness of penetration immediately after treatment and say four weeks after treatment?*

Several experiments were carried out independently by different members of the Committee. It is not possible from these experiments to state definitely the extent to which creosote oil may be depended upon to spread after treatment, but they all indicate very clearly that a certain amount of spreading does occur if areas of untreated wood happen to be left between perforations. It can be said therefore that if the penetration between perforations is not complete at the end of the treating period it will at least be more nearly complete after a period of four or five weeks. In substantiation of these statements there are presented exhibit A, which is a report of experiments made at the Forest Products Laboratory by Mr. J. D. MacLean and Mr. C. E. Miller; exhibit B, which describes some experiments made by Mr. H. S. Vassar of the Public Service Electric Company of Newark, New Jersey; and exhibit C from Mr. C. H. Amadon of the Western Electric Company.

5. *When perforating is used is it necessary to shave off the inner bark?*

It is the opinion of the Committee that it is best to remove the bark completely, but strips of inner bark remaining on the pole are not likely to interfere materially with the penetration when the pole is perforated. A more important consideration appears to be the danger of bark collecting upon the shoulder of the perforating instrument and thus reducing the depth of the perforations. Other good reasons for rather completely removing the bark are that strips of bark give the pole an undesirable appearance and they undoubtedly absorb a certain amount of oil which is wasted. Information upon this question is given in the report by Mr. John D. Burnes, which is attached to this report as exhibit D.

6. *What is the most efficient size and shape of the punch?*

No experiments have been made to determine the most satisfactory type of tooth. It seems desirable, however, to make the tooth so that both the length and breadth of the perforation will be as small as possible consistent with the required strength of tooth. A short perforation will permit closer spacing along the pole without overlapping perforations in adjacent lines, and by using a narrow tooth a smaller portion of the circumference will be cut for a given width of spacing.

The Committee believes that further study on the perforating process is very desirable, and for the consideration of next year's Committee it makes the following recommendations:

1. Continue consideration of effect of perforations on strength and have strength tests made if an opportunity can be found.
2. Study perforating patterns with a view to developing patterns which will give complete and uniform penetration, with the least possible proportion of wood cut from the circumference.
3. Continue study of size and shape of perforating tooth.
4. Secure data on relative amounts of oil absorbed by perforated and unperforated poles.
5. Continue study to determine the effect of the perforations upon checking.
6. Secure detailed treating and setting records on representative pole lines set with perforated and unperforated creosoted poles.

L. L. HILL, *Chairman*,
C. H. AMADON,
L. A. FURLONG,
W. M. LEAVITT,
C. M. SPORLEY,
W. K. VANDERPOEL.

ROGER F. HOSFORD, *General Chairman*.

EXHIBIT A.

THE SPREADING OF CREOSOTE FROM PERFORATIONS IN CEDAR POLES

In order to secure some authentic information on the spreading of creosote from the perforations in cedar poles after the treating operations have been completed, several experiments were made at the Forest Products Laboratory by J. D. MacLean and C. E. Miiller, using sections of western red cedar and northern white cedar poles furnished by the Page and Hill Company of Minneapolis. There were three sections of each species, about 2½ feet long and 6 inches to 8 inches in diameter. One section of each species was green, one partly seasoned, and one air dry. The moisture content of the green material was about 30 to 45 per cent, and of the air dry and partly seasoned material about 7 to 15 per cent. Table 1 gives additional data on the character of each section.

TABLE 1. DATA ON CHARACTER OF SPECIMENS USED

Mark	Species	Degree of Seasoning	Volume, cu. ft.	Average Rings per Inch	Average Depth of Sapwood Inches
N-1	Northern white cedar	Green	0.55	15	0.50
N-2	"	Partially seasoned	0.48	30	0.50
N-3	"	Seasoned	0.33	35	0.40
W-1	Western red cedar	Partially seasoned	0.54	18	0.50
W-2	"	Seasoned	0.78	11	0.88
W-3	"	Green	1.17	37	0.60

Preparation and Treatment.

All the pieces were perforated ¾ inches deep. The perforations in the seasoned and partially seasoned pieces were spaced 12 inches apart longitudinally and 2 inches around the circumference. Each row of perforations was staggered. Perforations in the green pieces were spaced 8 inches apart longitudinally and 1½ inches apart around the circumference. The pieces were perforated to within about 6 inches of each end and around approximately ¾ of the circumference. The object of spacing the holes so far apart was to provide sufficient space between them to observe the progress of the oil after treatment.

The pieces were all treated by the open tank method using a treating period of 1½ hours in the hot bath and 1½ hours in the cold bath. A temperature of 212° F. was employed during the hot bath treatment and a temperature of 105° to 108° F. for the cold bath. This treatment was sufficiently severe to give considerable penetration and fill the holes with oil, but not severe enough to cause complete penetration of the sapwood and thus obscure the results.

After treatment the specimens were allowed to stand one week in order to drain off and evaporate the excess oil on the surface and in the perforations.

Measurement of Penetration.

In order to obtain average values on the increase of penetration after treatment, a part of each specimen was sawed radially through a row of perforations. The penetrated area was surfaced with a sharp knife or plane and measurements made of the average penetration in the sapwood and heartwood. This penetration was outlined with small punch marks at close intervals. At the subsequent measurement the exposed area was lightly surfaced again with a knife or plane and the penetration beyond the original outline measured. A new series of perforations were also sawed and measured at each time penetrations were determined.

Tables 2 and 3 show the results of these measurements. Series A shows average penetration measurements made on the same perforations at different times. Series B gives an average of penetration measurements made on a second group of perforations cut later, and series C and D are measurements made on a third and fourth group of perforations cut through at still later dates.

Discussion of Results.

The absorptions varied from 2 pounds to 2¼ pounds per cubic foot in the green sections, from 6 to 9 pounds in the partly seasoned sections and from 14 to 15 pounds in the seasoned sections.

The penetration measurements showed that the creosote continued to spread after treatment. In these experiments the spreading was found to be most rapid during the first two or three weeks and showed but little if any progress when measurements were made from four to six weeks after treatment. The spreading of the oil was mainly in a longitudinal direction.

The increases in longitudinal penetration which took place after the first seven days are shown in table 2, which is summarized from the detailed data shown in table 3. These figures represent the amount of spreading which occurred after the first week. An appreciable amount of spreading undoubtedly took place during the first seven days, and the total amount of spreading was therefore greater than is indicated by table 2.

TABLE 2. INCREASE IN LONGITUDINAL PENETRATION

Spec. No.	Increase in Longitudinal Penetration		Condition and Species
	Inches		
	Sapwood	Heartwood	
N-1	1.02	0.78	Northern white cedar, green
N-2	1.30	0.46	Northern white cedar, partially seasoned
N-3	.......(a).......	1.31	Northern white cedar, seasoned
W-1	0.67	0.73	Western red cedar, partially seasoned
W-2	.......(a).......	1.02	Western red cedar, seasoned
W-3	.......(a).......	0.17	Western red cedar, green

(a) Penetration complete between perforations. Very light in summerwood of green specimens.

The absorption of oil was from 6 to 7 times greater in the seasoned than in the green pieces. This resulted in a much heavier saturation of the penetrated wood, in the case of seasoned material, and provided a greater supply of oil for further spreading subsequent to treatment.

The penetration in the green material was chiefly in the summerwood, even in the sapwood, whereas both springwood and summerwood were usually penetrated in the seasoned specimens.

The tangential penetration in the green sapwood extended from ⅜ to ½ inch from the perforations and was complete between perforations in the seasoned sapwood.

There was practically no radial or tangential penetration in the heartwood of either the green or seasoned sections.

This experiment was not made on a large enough scale to permit conclusions as to the extent to which creosote oil may be depended upon to spread in the wood after treatment, but it does indicate clearly that if untreated areas exist between the perforations after treatment the spreading of the creosote will reduce these areas to an appreciable extent.

TABLE 3. SPREADING OF CREOSOTE FROM PERFORATIONS

Spec. No.	Days elapsed after treatment	Measurement No.	Ave. Longitudinal Penetration from Perforations		Condition and Species
			Sapwood, inches	Heartwood, inches	
			Series A		
N-1	7	1	1.81	0.56	Northern white cedar, green
	21	2	2.83	1.27	
	44	3	2.83	1.36	
	58	4	2.83	1.34	
N-2	7	1	1.80	0.42	Northern white cedar, partially seasoned
	21	2	2.72	0.62	
	44	3	3.10	0.88	
	58	4	3.10	0.88	
N-3	7	1	3.22	1.74	Northern white cedar, seasoned
	21	2	3.23	2.71	
	44	3	....(a)	3.05	
	58	4	....(a)	3.05	
W-1	7	1	4.63	0.97	Western red cedar, partially seasoned
	21	2	5.30	1.70	
	44	3	5.30	1.70	
	58	4	5.30	1.70	
W-2	7	1	2.56	0.96	Western red cedar, seasoned
	21	2	....(a)	1.98	
	44	3	....(a)	1.98	
	58	4	....(a)	1.98	
W-3	7	1	....(a)	0.58	Western red cedar, green
	21	2	....(a)	0.70	
	36	3	....(a)	0.75	
	50	4	....(a)	0.75	
			Series B		
N-1	23	1	2.30	0.60	Northern white cedar, green
	45	2	2.34	0.98	
	58	3	2.34	0.98	
N-2	23	1	3.90	1.20	Northern white cedar, partially seasoned
	45	2	3.90	1.20	
	58	3	3.90	1.20	
N-3	23	1	3.30	3.60	Northern white cedar, seasoned
	45	2	....(a)	3.60	
	58	3	....(a)	3.60	
W-1	23	1	4.60	1.10	Western red cedar, partially seasoned
	45	2	5.30	1.24	
	58	3	5.30	1.24	
W-2	23	1	....(a)	....(a)	Western red cedar, seasoned
	45	2	....(a)	....(a)	
	58	3	....(a)	....(a)	
W-3	20	1	....(a)	0.56	Western red cedar, green
	37	2	....(a)	0.56	
	50	3	....(a)	0.56	

TABLE 3.—SPREADING OF CREOSOTE FROM PERFORATIONS—Continued.

Spec. No.	Days elapsed after treatment	Measurement No.	Ave. Longitudinal Penetration from Perforations		Condition and Species
			Sapwood, inches	Heartwood, inches	
			Series O		
N-1	44	1	....(a)	....(a)	Northern white cedar, green
	58	2	....(a)	....(a)	
N-2	44	1	2.50	1.25	Northern white cedar, partially seasoned
	58	2	2.50	1.25	
N-3	44	1	....(b)	....(b)	Northern white cedar seasoned
	58	2	....(b)	....(b)	
W-1	44	1	2.58	1.15	Western red cedar, partially seasoned
	58	2	2.58	1.15	
W-2	44	1	3.15	1.14	Western red cedar, seasoned
	58	2	3.15	1.14	
W-3	36	1	1.33	0.68	Western red cedar, green
	50	2	1.33	0.68	
			Series D		
N-1	59	1	....(a)	0.69	Northern white cedar, green
N-2	59	1	1.58	....(a)	Northern white cedar, partially seasoned
N-3	59	1	....(b)	....(b)	Northern white cedar, seasoned
W-1	59	1	1.93	1.20	Western red cedar, partially seasoned
W-2	59	1	....(b)	2.18	Western red cedar, seasoned
W-3	51	1	....(a)	0.62	Western red cedar, green

(a) Penetration complete between perforations. Very light in summerwood of green specimens.

(b) Specimen completely sawed at time of previous measurement.

EXHIBIT B.

CREOSOTE PENETRATION TESTS OF POLE BUTTS.

Report of H. S. Vassar, Laboratory Engineer, Testing
Laboratory of the Public Service Electric
Company, Newark, N. J.

Note: Due to the condition of samples, it was found necessary to change the test as outlined by Mr. Hill, and in accordance with verbal request of Mr. Ware the object of the test was changed to a determination of the effect of perforations on penetration.

Material.

Six samples were submitted, said to be as follows:

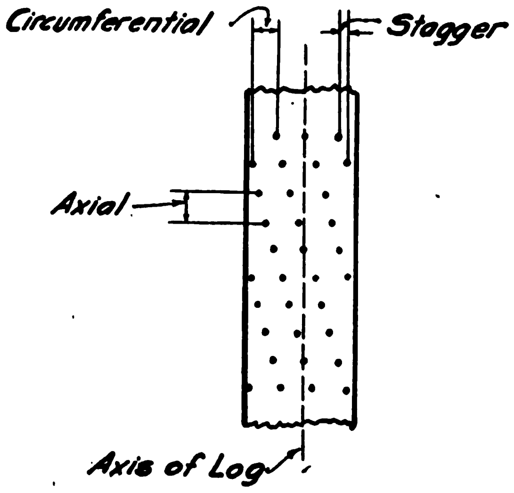
No. 1	Northern white cedar—seasoned.
No. 2	" " " —partially seasoned.
No. 3	" " " —green.
No. 4	Western red cedar—seasoned.
No. 5	" " " —partially seasoned.
No. 6	" " " —green.

In size the logs averaged about 3 feet in length and ranged from 5 to 10 inches in diameter.

Test Methods.

A three inch piece was discarded from the end of each log and a cross-sectional sample 1 inch in thickness taken. From this the percentage moisture content was obtained by drying at 110° F. until successive measurements at 24 hour intervals indicated no loss of weight.

The surface of each log was then divided axially into four sections and perforations were made with spacings as indicated below.



Section A	1 inch axial ½ inch circumferential ⅛ inch stagger
Section B	2 inches axial 1 inch circumferential ¼ inch stagger
Section C	3 inches axial 1½ inches circumferential ⅜ inch stagger
Section D	Unperforated

The perforations, ½ inch deep, ¼ inch axially of the log and ⅛ inch circumferentially, were made by driving in a steel tool of these dimensions.

The ends having been thoroughly sealed by four coats of water glass, the samples were submerged in coal tar creosote. After 24 hours, during which the temperature of the creosote was as shown by the attached copy of the graphic thermometer* chart, the logs were removed and sawed axially into four quarters corresponding to the sections described above.

These quarters were then cut and split and the creosote penetration determined as nearly as possible in all parts of the specimens.

Test Results.

MOISTURE CONTENT AS RECEIVED

Sample	Moisture Content by Weight—Per cent.
1	7.2
2	7.7
3	20.7
4	8.8
5	8.1
6	29.2

CREOSOTE PENETRATION FROM PERFORATIONS

Section Mark	Axially			Circumferentially			Radial Penetration from Surface		
	Max. (in.)	Min. (in.)	Avg. (in.)	Max. (in.)	Min. (in.)	Avg. (in.)	Max. (in.)	Mir (in	Avg. (in.)
Sample 1									
A	....	2	2¾	....	1/16	⅛	⅝	5/16	½
B	....	2	2¾	3/16	1/16	⅛	⅝	5/16	½
C	....	1¼	2½	⅛	0	1/16	9/16	5/16	½
D	....	....	....	....	....	....	½	⅜	7/16

COMMENTS: In all sections there was complete and uniform penetration to a depth of nearly ½ inch. Slightly more penetration occurs near perforations. All measurements as given were made at depth of ½ inch or more.

Sample 2

A	....	¾	1½	⅛	1/16	⅛	9/16	9/16	⅝
B	2¼	1¼	1¾	¼	1/16	3/16	½	1/16	⅛
C	1¾	1	1½	⅛	1/16	⅛	½	1/16	1/16
D	....	....	....	....	....	....	⅛	1/16	1/16

COMMENTS: In this specimen the effect of perforations was very noticeable. In B below ⅛ inch depth creosote follows stagger of perforations, leaving untreated wood between. Greater stagger apparently would give uniform penetration to greater depth.

---

* Chart showed 105° F. beginning, 220° at end of second hour, above 220° for next 11½ hours, with a maximum of 242°, then steady cooling to 80° at the end of the 24 hour period.

Sample 3

A...........	....	2½	3	¼	1/16	⅛	¾	⅛	⅜
B...........	....	3	3½	⅝	⅛	3/16	⅝	1/16	⅛
C...........	6	3	4½	5/16	1/16	3/16	½	1/16	1/16
D...........	Practically no penetration except near weather checks.								

COMMENTS: In this sample creosote showed very decided tendency to follow annual rings. Perforations necessary to get any penetration, and the closer the spacing the greater the depth of uniform penetration.

CREOSOTE PENETRATION FROM PERFORATIONS—continued

Section Mark	Axially			Circumferentially			Radial Penetration from Surface		
	Max. (in.)	Min. (in.)	Avg. (in.)	Max. (in.)	Min. (in.)	Avg. (in.)	Max. (in.)	Min. (in.)	Avg. (in.)

Sample 4

A...........	....	....	....	....	....	....	⅞	⅞	⅞
B...........	....	....	....	....	....	....	⅞	⅞	⅞
C...........	....	....	....	....	....	....	⅞	⅞	⅞
D...........	....	....	....	....	....	....	⅞	⅞	⅞

COMMENTS: Complete and uniform penetration to a depth of ⅞ inch. In this case it is noted that the penetration was as complete in the unperforated as in the perforated sections.

Sample 5

A...........	....	....	....	....	....	1⅛	⅝	7/16	½
B...........	....	3¼	3½	⅜	1/16	⅛	¾	½	9/16
C...........	6	3	3½	¼	⅛	⅛	⅝	¼	5/16
D...........	....	....	....	....	....	....	5/16	¼	¼

COMMENTS: Penetration averages deeper in B than A, apparently because of deeper sap wood on that side of log. Effect of holes very marked, but difficult to get axial or circumferential travel in A or B because penetration is practically complete for depth of perforations.

Sample 6

A...........	5	3	3½	¼	1/16	⅛	⅞	⅛	7/16
B...........	5	3	4	½	⅛	3/16	½	⅛	5/16
C...........	6	3	3¼	5/16	1/16	3/16	⅝	1/16	⅛
D...........	No penetration whatever								

COMMENTS: Perforations add much to penetration, but even with A spacing there are streaks of untreated wood at not over ⅛ inch from surface, apparently due to grain structure or moisture in wood. After standing in a dry room for seven days these untreated spots almost entirely disappear.

EXHIBIT C.

STUDY OF INITIAL PENETRATION AND SUBSEQUENT MOVEMENT OF CREOSOTE IN CEDAR PERFORATED TO FACILITATE TREATMENT.

C. H. Amadon.

Materials.

Wood: Sample 1—Northern white cedar, thoroughly seasoned.
" 2—Northern white cedar, green.
" 3—Western cedar, thoroughly seasoned.
" 4—Northern white cedar, thoroughly seasoned.
" 5—Western cedar, green.

Creosote: Conforming to standard specifications for brush and open tank treatment.

Perforating Points: ⅛ inch wide, ¼ inch long, making a puncture ⅜ inch deep.

Method.

The samples were prepared for treatment by removing all adhering inner bark and were punctured at wide intervals, so as to afford sufficient space to permit observation of the subsequent creepage of oil into the untreated wood.

The moisture content of each sample was determined, and the samples classified as thoroughly seasoned or green, the classification being based primarily on the moisture content of the sap wood and the outer one-half of the heart wood.

The treatment of the test samples was by immersion in the preservative at the temperatures and for the periods noted on the accompanying table.

On the day following the treatment each sample was split in several test pieces so as to open a plane through one or more perforations in each piece and expose the treated wood. The pieces were suitably numbered for subsquent identification and a sketch made on tracing cloth, recording the initial penetration obtained, using black ink for the purpose. No attempt was made to show the radial penetration and no pieces were prepared to show tangential penetration.

TABULATION SHOWING INITIAL PENETRATION AND SUBSEQUENT MOVEMENT OF CREOSOTE FROM PERFORATIONS IN CEDAR POLES

Test Piece Number	Species of Timber	State of Seasoning	Initial Maximum Longitudinal Oil Penetration from Perforation		After 4 Weeks Maximum Longitudinal Oil Penetration from Perforation		Duration of Immersion in Creosote at 220° F.
			Complete	Summer Zone	Complete	Summer Zone	
			Inches	Inches	Inches	Inches	Hours
2-1	Northern White	Green	2 3/4	3 3/8	....	....	2 1/2
2-2	“ “	“	2 1/8	2 11/16	....	....	2 1/2
3-1	Western Red	Thoroughly seasoned	2 1/4	3 1/8	2 5/8	3 5/8	7
3-2	“ “	“ “	2 5/8	2 7/8	....	6 1/16	7
3-3	“ “	“ “	2 1/8	3 1/2	....	6 1/16	7
4-1	Northern White	“ “	1/2	3/4	2 1/8	2 5/8	2 1/2
4-2	“ “	“ “	2	4 1/4	....	4 3/4	2 1/2
4-3	“ “	“ “	1 1/2	2 15/16	....	....	2 1/2
4-4	“ “	“ “	1 1/4	4	....	....	2 1/2
5-1	Western Red	Green	1	1 9/16	....	....	1 1/2
5-2	“ “	“	1 1/8	3 1/2	....	....	1 1/2
5-3	“ “	“	1	1 15/16	....	2 1/2	1 1/2
5-4	“ “	“	11/16	1 3/4	....	1 13/16	1 1/2
3-1-B	“ “	Thoroughly seasoned	1 1/8	1 3/4	....	3 3/4	2
3-2-B	“ “	“ “	3/4	1 3/4	2 1/2	2 3/4	2
3-3-B	“ “	“ “	1	1 9/16	1 3/8	2 3/4	2
3-3-B-1	“ “	“ “	1 1/8	1 7/8	....	2 1/8	2
3-3-B-2	“ “	“ “	2	2 1/2	....	2 15/16	2
4-1-B-1	Northern White	“ “	1/2	1 1/4	1 1/16	1 5/8	2
4-1-B-2	“ “	“ “	2 1/8	2 9/16	4	....	2
4-2-B-1	“ “	“ “	1 1/2	1 3/8	.1 3/8	1 11/16	2
4-2-B-2	“ “	“ “	1 1/2	1 13/16	2 1/16	4 5/8	2
4-3-B-1	“ “	“ “	2	2 3/8	2 1/2	3 1/8	2
4-3-B-2	“ “	“ “	1 1/4	1 5/8	1 5/8	2 1/2	2
5-1-B	Western Red	Green	7/8	....	1	1 9/16	2
5-2-B	“ “	“	1 1/16	3 5/16	1 3/4	4	2
5-3-B	“ “	“	2 1/2	3 1/16	....	2 3/4	2

NOTE: Where no figures are shown in the 3rd and 4th columns, penetration after 4 weeks did not exceed initial penetration. That is, there was no movement of oil.

At the end of four weeks the movement of creosote during the interval was recorded on the sketches in red ink. Each sketch, therefore, shows the initial penetration obtained and impregnation resulting from creepage after four weeks. Reproductions of several of the sketches showing the poorest and the best results obtained are shown in the accompanying plate.

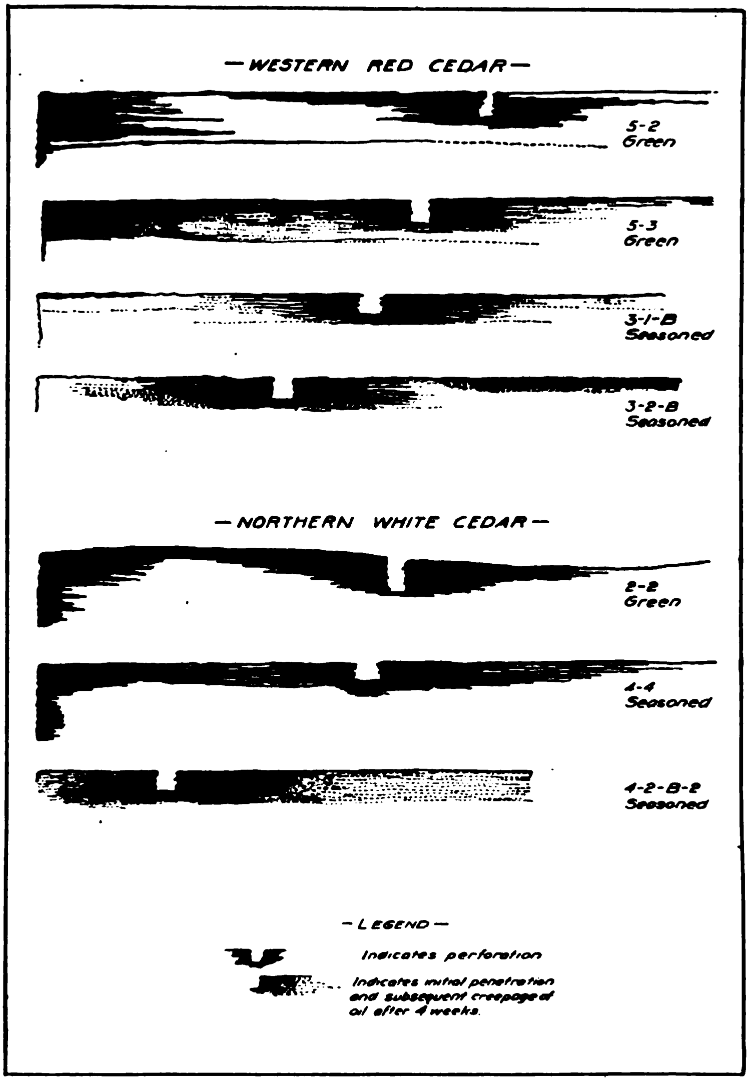

—WESTERN RED CEDAR—
5-2 Green
5-3 Green
3-1-B Seasoned
3-2-B Seasoned
—NORTHERN WHITE CEDAR—
2-2 Green
4-4 Seasoned
4-2-B-2 Seasoned
—LEGEND—
Indicates perforation
Indicates initial penetration and subsequent creepage of oil after 4 weeks.

EXHIBIT D.

EFFECT OF INNER BARK UPON THE PENETRATION OF CREOSOTE OIL INTO PERFORATED AND NON-PERFORATED NORTHERN AND WESTERN CEDAR.

J. D. Burnes.

The sections used in this experiment were 6-inch 7-foot posts. The unseasoned samples were received at the plant unpeeled. The seasoned samples had been peeled, leaving the inner bark and strips of the outer bark. The green samples were peeled just prior to the beginning of the experiment.

Areas B and D as shown in the diagram, were then shaved removing all inner and outer bark. Areas A and C were left with inner bark and some strips of outer bark adhering to the wood.

The word "peeled" as used in this report indicates the usual removal of outer bark as performed by pole makers, which invariably leaves strips of outer bark on the pole.

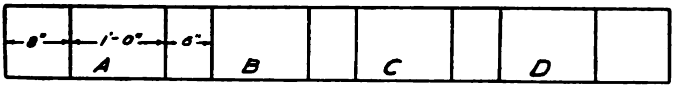
For this experiment the inner bark is defined as that portion of the bark consisting of the cambium and the layer which was alive when the tree was cut. This layer varies from 1/64 to 1/8 inch in thickness.

Condition of the Seasoning of Sections.

Section 1. Northern white cedar fully seasoned.
Section 2. Northern white cedar partially seasoned.
Section 3. Northern white cedar green.
Section 4. Western red cedar fully seasoned.
Section 5. Western red cedar partially seasoned.
Section 6. Western red cedar green.

Owing to the difficulty of getting material with sufficient inner bark, six sections were taken for the experiment instead of twelve.

Preparation of Sections for Treatment.



The diagram shows the distribution of the different areas in the stick:

Area A is the perforated unshaved surface.
Area B is the perforated shaved surface.
Area C is the non-perforated unshaved surface.
Area D is the non-perforated shaved surface.

Each area is one foot in length and extends entirely around the section at the points shown in the diagram.

Methods of Treatment.

The sections were treated throughout their entire length for eight hours in hot oil and two hours in cold. The temperature of the hot creosote oil was 226° F. and that of the cold creosote oil 80° F.

After treatment each piece was cut into its various sections. Each section was quartered and measured at the center point for the penetration of creosote oil.

Observations After Treatment.

Weather checks which would influence the penetration of the oil into the wood were carefully avoided in making these measurements.

SECTION 1, NORTHERN WHITE CEDAR, SEASONED

Quarters	Penetration in 32nds of an inch				
	1	2	3	4	Average
Area A perf. unshaved	12	8	12	8	10
Area B perf. shaved	16	12	14	18	15
Area C unperf. unshaved	2	6	2	2	3
Area D unperf. shaved	6	2	4	2	3 plus

The difference in penetration in Areas A and B was due to the bark clogging the teeth of the machine. The oil in every case penetrated to the bottom of the perforations which were not as deep in the unshaved area as in the shaved area. The difference between Areas C and D was so small that it is within the range of experimental error in measuring.

SECTION 2, NORTHERN WHITE CEDAR, PARTIALLY SEASONED

Quarters	Penetration in 32nds of an inch				
	1	2	3	4	Average
Area A perf. unshaved	12	16	16	16	15
Area B perf. shaved	16	16	16	16	16
Area C unperf. unshaved	2	3	2	4	3 minus
Area D unperf. shaved	3	4	3	3	3 plus

Areas A and B still show a difference of 1/32 inch due to bark clogging the teeth of machine. Areas C and D show a difference of not quite 1/32 inch in favor of the shaved surface. Oil penetrated completely through the bark at all measurements.

Section 3 was in a very green condition when treated. It was cut green in the woods, and shipped unpeeled. It was wrapped so that seasoning amounted to very little during shipment.

SECTION 3, NORTHERN WHITE CEDAR, GREEN

Quarters	Penetration in 32nds of an inch				
	1	2	3	4	Average
Area A perf. unshaved	16	16	14	12	14 plus
Area B perf. shaved	16	14	18	16	16
Area C unperf. unshaved	4	3	1	4	3
Area D unperf. shaved	4	1	4	4	3 plus

The penetration in area A was 1/16 inch less than in area B, due to the bark preventing the teeth entering the wood to their full depth. In areas C and A the oil had difficulty in penetrating through the green inner bark. The oil was observed in the wood underneath the bark yet there was a streak of uncreosoted fibre running through the middle portion of the bark.

SECTION 4, WESTERN RED CEDAR, SEASONED

Quarters	Penetration in 32nds of an inch				
	1	2	3	4	Average
Area A perf. unshaved	12	18	16	16	15 plus
Area B perf. shaved	14	16	14	16	15
Area C unperf. unshaved	14	8	8	8	9 plus
Area D unperf. shaved	10	14	8	6	9 plus

The difference between areas A and B is very slight and is within the experimental error of measuring. No difference was shown between the unperforated unshaved area and the unperforated shaved.

SECTION 5, WESTERN RED CEDAR, PARTIALLY SEASONED

Quarters	Penetration in 32nds of an inch				
	1	2	3	4	Average
Area A perf. unshaved	14	16	12	12	13 plus
Area B perf. shaved	16	16	16	14	15 plus
Area C unperf. unshaved	2	2	3	2	2 plus
Area D unperf. shaved	2	3	2	2	2 plus

There is a difference of 1/16 inch in the perforated shaved and unshaved surfaces and no difference between the non-perforated shaved and unshaved surfaces.

The condition of the green section 6 was the same as that of the green northern white cedar described in section 3.

SECTION 6, WESTERN RED CEDAR, GREEN

Quarters	Penetration in 32nds of an inch				
	1	2	3	4	Average
Area A perf. unshaved	4	12	16	14	11 plus
Area B perf. shaved	18	12	16	16	15 plus
Area C unperf. unshaved	4	2	0	4	2 plus
Area D unperf. shaved	2	8	6	2	4 plus

In area C the oil did not penetrate through the inner bark leaving the wood fibre without visible trace of creosote. The perforated unshaved showed 1/8 inch less penetration than the perforated shaved area.

Conclusions.

From the above observations it appears that the effect of the inner bark on the penetration of creosote oil into perforated wood is a mechanical one, resulting from portions of the inner bark coming loose and preventing the perforating teeth from going in their full length. The loss in penetration on all areas on account of the inner bark varied from 5/32 to 1/32 inch. In all cases the oil had apparently little trouble in penetrating the wood beneath the perforated bark.

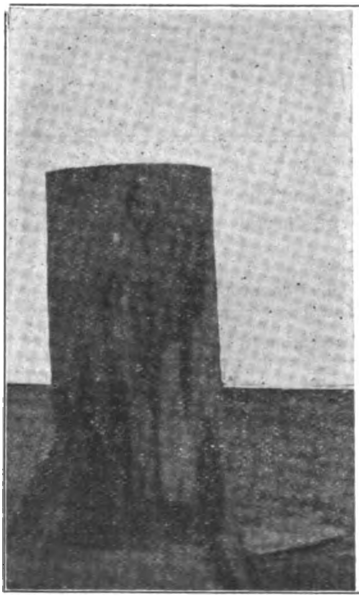


Fig. 1. Showing the inner bark pulled off from treated section. Note the white area showing absence of creosote

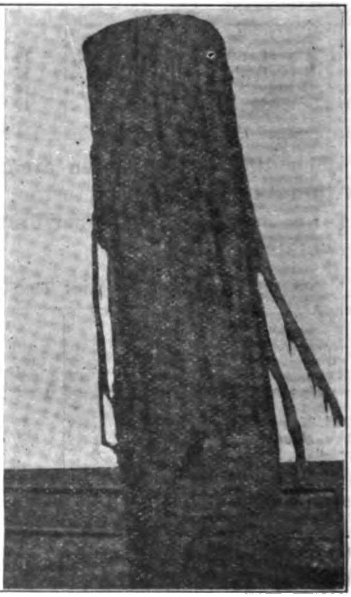


Fig. 2. Showing how the inner bark is pulled loose by the perforating machine.

The leaving of the inner bark on during treatment had no visible effect on the checking of the wood during treatment.

In non-perforated poles the bark problem becomes more serious. In partially seasoned and thoroughly seasoned poles there is some loss due to the presence of inner bark but this loss is very slight, varying in the observations above from 1/16 inch to nothing. In green poles and in poles where inner bark is bright green in color and adheres very closely to the wood, creosote oil has considerable trouble in getting thru the inner bark, in some cases, not penetrating at all, as in the case of the green sample of western cedar used in this experiment.

MR. HOSFORD: I move that the report be accepted as information.

MR. M. J. CURTIN: I second the motion.

THE PRESIDENT: It is moved and seconded that this report be accepted as information. It is now open for discussion.

MR. LARKIN: I would like to refer again to the question with reference to the possibility of the penetration by any process of the heartwood.

MR. HOSFORD: You will find considerable material bearing on that in some of these reports. I think possibly the greatest amount of information will be the report by Mr. McLean and Mr. Miller. The indications are, so far as any one has gone yet, that the movement of creosote in the heartwood is so much less, either longitudinally or radially, that you can say there is very little chance, in sight anyway, of action in the heartwood. Some longitudinal movement is reported, but it is so much less than the movement in the sapwood that I do not see how any one could make use of that fact in a practical way.

MR. LARKIN: Does that hold in the punctured material also?

MR. HOSFORD: Yes, this is the experiment carried out at the Forest Products Laboratory. I can't check this quick enough to answer you from the paper, because it is in so much detail, but they do give some information as to radial and tangential movement, as well as longitudinal movement from the punctures, and in the heartwood all three of them are relatively slight compared with the sapwood, and even taking the longitudinal case it is so small compared with the movement they get in the sapwood of the same piece that the prospect of having treated heartwood does not look very promising.

THE PRESIDENT: Are there any other remarks in connection with this motion? It is moved and seconded that the report of Committee 5-5-2 be accepted as information. All in favor of that motion please say "aye"; opposed, a like sign. It is so ordered. The Committee is excused with thanks.

The next report will be on inspection of treatment.

REPORT OF COMMITTEE NO. 5-9—INSPECTION

To the Members of the American Wood Preservers' Association:

The instructions of the Executive Committee were:

1. Take up treatment practices in detail with respect to the several processes, various species of wood, and different classes of material.
2. Ascertain when and where to take temperature of preservative in use, and effect of temperature on treatment.
3. Consider advisability of standard forms.
4. Study plant equipment with the idea of making useful suggestions.

Several meetings of the Committee were called during the year in Chicago, but only four members were present at any one time.

It was decided to divide the work up among sub-committees, and they were appointed as follows:

Sub-Committee 1—J. R. Keig, *Chairman*
F. S. Shinn
J. M. Black

Sub-Committee 2—E. T. Davies
C. M. Tilley

Sub-Committee 3—F. N. Graham
T. J. McGinty
J. R. Keig

Sub-Committee 4—T. J. McGinty
F. N. Graham
J. R. Keig

SUB-COMMITTEE 1: This Committee has done a great deal of work on the subject assigned to them, but does not consider their report complete and, therefore, will make a progress report at this meeting.

SUB-COMMITTEE 2: The members of this Committee were unable to meet due to the remoteness of their residences, and your Committee does not feel that the subject has been given as much consideration as it merits. However, it submits the following:

Your Committee believes that if the preservative in working or other tanks is sufficiently agitated and a thermometer is placed a convenient distance from the ground on the side of the tank, it will be satisfactory for all practical purposes. If possible we think the thermometer should be protected from the elements and sufficiently illuminated (this applies especially to working tanks), so that it would be possible to take temperatures with accuracy at night when necessary.

When temperature is taken at time of inventory, the preservative should be well agitated, if practicable. The temperature can be taken by dropping the thermometer into the oil by means of a cord suspended from the top of the tank. Care must be taken to lower the thermometer to the correct depth. Temperature can also be obtained from direct-reading thermometers installed on side of tank. When taking temperature from a direct-reading thermometer it is well to draw off a quantity of preservative from a pet cock provided for that purpose, in order that the reading may be as nearly as possible an average temperature.

Temperatures should be taken whenever an inventory is made of preservatives. It should also be taken just before the preservative is introduced into the treating cylinder, during progress of treatment, and after returning preservative to working tank. Temperature taken from recording thermometer during treatment should be checked by means of a direct-reading thermometer on the side of the cylinder.

Your Committee believes that an average temperature of 130 to 150 degrees F. should be maintained at all times in treating cylinders during treatment with zinc chloride. With oil or a mixture of oil and zinc chloride, we think the average temperature during treatment should be 170 to 190 degrees F. The viscosity of the oil should be a governing factor in temperature. It is well to take temperature shortly after the cylinder is filled and a sufficient number of times thereafter to know that proper temperature is being maintained.

We consider temperature a most important factor in the treatment of timber.* Satisfactory temperature aids penetration by expansion of the wood pores and prevents excessive recovery when pressure is released by rendering the wood cells more pliant. Increase of temperature renders the preservative less viscous, or of a lower viscosity, and, obviously, more susceptible to absorption and, consequently, better penetration.

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* References in 1921 A. W. P. A. Proceedings on effect of temperature:

Page 52—Paragraph (b) solution of ZnO in $ZnCl_2$ and temperature.
Page 61—Table giving effect of temperature on gravity.
Page 91—Paragraph (1) effect of high temperature on stored lumber and following pages.
Page 145—Comparison of creosote and cres-oil temperature.
Page 458-9—Localized pressure treatment—temperature effect.

SUB-COMMITTEE 3: Considerable work has been carried throughout the year, and numerous forms have been collected from which studies have been made. However, this Committee desires at this time to submit only the attached form* as information.

SUB-COMMITTEE 4: Treating plants should be so constructed and equipped as to conserve the important points in timber preservation and plant operation, viz., through treatment and economical plant operation.

Your Committee defines thorough treatment as the best possible treatment that can be obtained with the present up-to-date equipment. Economical plant operation implies that a plant be so constructed and equipped that it can be operated with the greatest efficiency practicable with a minimum cost of plant labor, fuel, and maintenance. All pumps, boilers, and engine-room equipment should be of the best type and properly maintained. Leaks in valves, pipe lines, and cylinders should be repaired as soon as possible as delay causes added expense as well as likelihood of a possible shut down and consequent decrease in output.

Your Committee considers the proper installation of recording gauges and thermometers, as well as direct reading thermometers, in cylinders a most important consideration in good treatment. Recording gauges and thermometers are considered more reliable when installed on the gauge board in the engine room where engineer and inspector can check them at all times. These are delicate instruments, and the possibility of neglect and damage from preservative or otherwise is greater when installed at a location other than in plain sight of operator.

The direct-reading thermometer should be installed on side near middle of cylinder, half way between front and back. The lug containing the thermometer bulb should be equipped with a pet cock to enable the operator to draw off a quantity of preservative before the temperature is taken. The recording thermometer bulb should be installed in the cylinder at or near the location of the direct-reading thermometer. Recording pressure gauges should be protected against the preservative by means of oil seals or diaphragms.

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* Form too large to reproduce in printed report. Blueprint may be obtained from the Secretary at cost of printing.

A well equipped treating plant should have the following modern equipment:

Boiler Steam Pressure	Recording as well as indicating gauge
Vacuum	Indicating gauge for each cylinder Recording gauge for each cylinder
Preservative Pressure	Indicating gauge for each cylinder Recording gauge for each cylinder
Temperature in Cylinders	Recording gauge for each cylinder Fahrenheit thermometer on each cylinder
Temperature in Tanks	Fahrenheit thermometers on all storage, working, measuring and pressure tanks

Unsettled conditions during the past year prevented your Committee from covering the subjects assigned to them as thoroughly as they should like to have done, and it is recommended that subjects 1, 3, and 4 be made future Committee work.

J. R. KEIG, *Chairman*
F. S. SHINN
J. M. BLACK
E. T. DAVIES
C. M. TILLEY
F. N. GRAHAM
T. J. MCGINTY

MR. KEIG: I move that the report be accepted as information.

MR. HOSFORD: I second the motion.

THE PRESIDENT: It is moved and seconded that the report of Committee 5-9 on Inspection be received as information. Are there any comments at this time?

MR. MEYER: Mr. President, I think this report is excellent, and those men ought to be complimented on their work. However, I wish to say that I do not think they have gone quite far enough. We would like to have more information about the inspectors, what they wish to do, and what they want. I think every operator, more especially those who operate commercial plants, will agree with me that every new inspector we get at the plant wants new apparatus. One inspector will want one kind of apparatus, and another inspector will want another. Consequently, we are at sea at all times to know just what is wanted. If there was some way we could get together and decide on some standard apparatus for the use of inspectors and for use at the plant in general a great deal would be accomplished. It would help to eliminate lots of inconvenience for the plant operator, and for the inspector. I wonder if it would be possible to put out a list of standard apparatus showing just what is wanted, and showing what every inspector could use and would be willing to use. I am often asked where there is a text book on wood preservation that gives all the details of inspecting wood when it is treated, and I am free to admit and have to admit that there is no such book that I know of. I refer men to the proceedings of the Wood-Preservers' Association. They say that is all right, but they don't go into details enough. A person has got to be a chemist to understand them. So for the good of the cause and the good of wood-preservation as a whole, I would suggest that the Committee on Inspection for the coming year bring out a list of apparatus they find sufficient for the work in any plant, and in addition—I don't know whether it is the proper place to take it up now or not—I would ask the Association if there is not some way whereby a publication can be issued giving all the details of how to test creosote and zinc chloride, giving the detail of how to make up the standard solutions, and so forth. There are many good operators here in the United States who never studied chemistry, and would give a whole lot to know just how this work is done.

THE PRESIDENT: I call Mr. Meyer's attention to the fact that the report of the Preservatives Committee last year and this year has given in detail the methods of making zinc-chloride solutions. There is much we have not done in connection with inspection; that we have in store for us in the future. I think the work done thus far indicates that the Committee is on the right track and we can expect from them in the future more detailed instructions as to the proper instruments which should be on hand at every treating plant for inspection work.

Last year's report of this Committee has in it something that I think Mr. Meyer can read to advantage and can use to advantage in case he gets into any argument with inspectors. Remember that our Inspection Committee is a committee that is in service the whole year. Don't hesitate, if you run against a situation that is not just what you think it ought to be, where you think the inspector is possibly unfair or unkind, or unjust, to make use of our Inspection Committee. Don't hesitate to ask their advice any time during the year when a problem comes up. That applies to every committee. Are there any other remarks in connection with this report?

MR. WALSH: Mr. President just following your remarks I think it would be a very wise idea to make the standing Committee on Inspection an arbitrating committee. Should any discussion arise between inspections on contracts that are made probably it would be agreeable to both parties to abide by their decision. I offer that as a suggestion to come up in the future.

THE PRESIDENT: I don't know whether the Committee would be willing to act as arbiter in disputes, but I will venture to say that when they make the decision there will be none of you who will go against it. Are there any other remarks in connection with this report? The motion is that the report be accepted as presented as information. All in favor of that motion please say "aye"; opposed, a like sign. It is so ordered, and the Committee is excused with thanks.

We come next to a paper that has been long wanted in our industry and which should be a great interest to all of us. It is by Earl Stimson, Chief Engineer of Maintenance of the Baltimore & Ohio, on "Should the Increased Cost of Treating Ties be Charged to Maintenance or Capital Account." Unavoidably, Mr. Stimson could not be here, and Mr, Angier will present his paper.

SHOULD THE COST OF TREATING TIES BE CHARGED TO MAINTENANCE OR CAPITAL ACCOUNT

By Earl Stimson
Chief Engineer of Maintenance
Baltimore and Ohio Railroad

The interest of the wood preserver in this question is only in so far as it affects the railroad's purchasing power. The degree of that purchasing power depends upon the funds available. It is therefore manifestly to the interest of the wood preserver that the necessary funds to pay the cost of treating ties are available.

These funds could be obtained in two ways, either from moneys earned or from moneys borrowed. Which of these ways is the more desirable from the railroad standpoint depends upon the degree of prosperity of the road or the state of its credit. If the earnings are large, it is desirable to put a portion back into the property, and in what better way than to invest in treatment for prolonging the life of ties. If the earnings are low, resort to capitalizing of the excess cost of the ties due to the treatment would be a means of meeting the expense. The road of low earning power would likely have poor credit and consequently difficulty in securing the necessary funds.

The manner of providing for this expense, however, has been prescribed by the Interstate Commerce Commission. Under account No. 8—Ties, of the Classification of Investment in Road and Equipment, Issue of 1914—we find in this connection, mention made only to including "the excess cost of metal ties used in repairs of track over the cost to replace in kind wooden ties removed." Under account No. 212, Ties—Classification of Operating Revenues and Operating Expenses of Steam Roads, Issue of 1914, we find—"This account shall include the cost of cross, switch, bridge and other track ties used in the repairs of tracks." Note B under this account states that, "The excess cost of metal ties applied in the place of wooden ties over the cost at current prices of replacing in kind the wooden ties removed shall be charged to road and equipment account No. 8, Ties."

While no specific mention is made of treated ties, it is plainly evident that the Commission does not consider the treatment of ties a "Betterment" in the sense in which that word is defined by the Commission. Such definition is given as, "Betterments are improvements of existing facilities through the substitution of superior parts for inferior parts retired, such as the substitution of steel-tired wheels for cast wheels under equipment, the application of heavier rail in tracks, and the strengthening of bridges by the substitution of heavier members. The cost chargeable to the accounts of this classification is the excess cost of new parts over the cost at current prices of new parts of the kind retired."

The wood preserver will of course take issue with this attitude of the Commission and no doubt feel much aggrieved at this classification as no betterment of the application of his art to the treatment of ties, and that he is being discriminated against in favor of the steel manufacturer. In fact one of the papers to be presented at this meeting openly implies that "this (the timber treating) industry has not been given fair treatment," by this classification of the Commission. While this may be a natural feeling of the wood preserver, and is to be pardoned as such, it must be borne in mind that it is the province of the Commission to conform the Classification of Investment in Road and Equipment Expenditures to the best general interests, rather than to use its prerogatives towards the fostering of a particular industry. It would be quite out of place for the Wood Preservers' Association to take up the question with the Commission on this basis.

The argument may be put forth that if the substitution of a metal tie for a wooden tie is a betterment, that is the substitution of a superior part for an inferior part, why not the substitution of a wooden tie which has had the length of its serviceability increased by chemical treatment.

This may be answered by stating that there is no reason why the treatment should not be classed as a betterment as the treatment undoubtedly makes the treated tie superior to the untreated tie, as far, at least, as its life as measured by its resistance to decay is concerned.

On the other hand it may be answered that there is sufficient reason why the treatment should not be classed as a betterment. In the case of the metal tie substituted for a wooden tie, there is unquestionably a substitution of a superior part for an inferior part, as the tie is made of a radically different and structurally superior material.

The Commission evidently considers a wooden tie, a wooden tie, whether of soft or hard wood—whether untreated or treated. A wooden tie structurally is no better after treatment. It will carry no greater load and will not better hold the spikes. Under severe usage it will no better resist rail and spike cutting, and other forms of mechanical wear, unless specially protected with tie plates and screw spikes at considerable additional expense. Under very severe usage the treated tie is destroyed as quickly as the untreated tie.

The increase in the length of life of the treated tie is the only point upon which its superiority can be based. The same point can be raised in favor of the white-oak or longleaf-pine tie, substituted for a red-oak or shortleaf-pine tie.

There are many kinds of treatment varying widely in cost and effectiveness, the effectiveness not always being in direct ratio to the costs. The effectiveness of treatments varies also with the kinds of wood. It is difficult after a few years to identify a tie, being removed from the track, as a treated or untreated tie, and if the former, the process of treatment used, unless a very elaborate record and method of marking for identification be initiated concurrent with the authority to charge the cost of treatment to Investment in Road, that is to Capital Account. Otherwise it would be impossible to accurately separate the charges.

The rapid rise in the price of timber has increased the price of the tie in much greater proportion than the cost of treatment has increased. Less expensive treatments, that have been found adequate, are being used more and more in place of the more expensive treatments formerly considered necessary. The result has been that the ratio of the cost of treatment to the price of the tie has greatly decreased, making the use of treatment not only show greater economies but also reducing the proportion the excess cost of treatment bears to the total cost of the treated tie. This should in itself stimulate the use of treated ties and not make necessary resorting to the doubtful expedient of capitalizing.

The steady increase of the use of treated ties, until now a large percentage of ties used are treated, rather nullifies the idêa that the present method of charging out the cost of treatment to Maintenance is preventing a more liberal use of treated ties.

Nor does it appear that the charging to Investment in Road, that is capitalizing, the excess cost of the metal tie has brought about the extensive use of that tie, or made it even a competitor of the treated tie. Millions of treated ties are used to thousands of metal ties.

The writer has treated this subject, not from the standpoint of the accountant or the financier, but rather from the more lowly standpoint, i. e., nearer the ground of the Maintenance Engineer. He has cheerfully taken into his maintenance costs the expense of treating to date some 12,000,000 ties. He is even now reaping to no inconsiderable extent the full benefits of the price paid. He is not and will not be compelled throughout all time to give up some portion of those benefits in payment of interest charges, or in other words, to pay tribute to Capitalizing. The writer favors the present practice of charging the cost of treating ties to Maintenance.

THE PRESIDENT: Gentlemen, there is lots of food for thought in that paper, and there are several here who want to discuss it. Mr. Kelleher, who was formerly a railroad man, and is now on the other side of the fence, has something to say.

MR. KELLEHER: Mr. President, the charge to maintenance of the extra cost of treated ties seems fundamentally wrong from the standpoint not only of the wood-preserving industry, but also in the interest of the economical maintenance of the railroads themselves, and more especially is this true in the case of those roads not so strong financially. Most railroads operate on the budget system, and when, as in the case at present, under the classification of the Interstate Commerce Commission, the entire cost of installing treated ties is charged to maintenance the human tendency of the officials of railroads not amply provided with funds is to make their budget go as far as possible for maintenance for the present day and the very immediate future, thus having in mind a relation of expenses during their own administration, letting the future take care of itself.

The fact that the Interstate Commerce Commission allows the excess cost of metal ties over ordinary untreated ties to be capitalized, disregarding the comparatively small number of metal ties in use as compared to treated ties, would from a sound business viewpoint justify a similar charge to capital of the cost of the treated tie in excess of the untreated tie.

The data presented to this Association of the results from use of treated ties to date is unanswerable as to their economy and if the railroads were allowed to capitalize the excess cost of the treated tie as they now do in the metal tie, many railroad officials would install treated ties in replacement of untreated ties with the resulting economy in maintenance over many successive years which surely would many times meet the comparatively small interest charge on the capitalization of the cost of the treated tie as compared with the untreated tie.

I believe also it would be interesting to ascertain whether in making this rule of charging to maintenance the cost of treated ties the Interstate Commerce Commission had before it full data and information in regard to the matter, and assuming that they had, whether in view of the unquestioned economy of treated ties as brought out by the recent tests and other data by this Asssociation, that the matter should not properly be reviewed by the Commission and the excess cost of treated ties be capitalized the same as in the case of metal ties which would simplify the problem of many operating and executive officers of railroads and allow them in many cases to substitute treated ties as the untreated ties are replaced.

MR. GRAHAM: I believe there is another point which touches along this same line, and that is, should not we charge to Additions and Betterments the excess cost of Grade 4 and 5 ties over Grade 3? In other words, the excess cost of 7 inch ties over 6 inch ties, just the same as you charge the extra weight of rail over what you replace.

THE PRESIDENT: Mr. Hendricks, who took the opposite viewpoint of this problem has a written discussion on this paper which the secretary will read.

Discussion by V. K. Hendricks.

When I implied in my paper on "Economics of Cross Tie Renewals" that the wood preservers were not receiving "fair treatment" under the Interstate Commerce Commission Classification of Accounts, it was far from my mind that there was any intentional unfairness, or that they were by any means the only ones who would benefit by a change which would capitalize the excess cost of treating ties. Possibly I should have hit upon a happier wording to convey that meaning without allowing the possibility of such an intimation.

I realize the difficulties in the way of capitalizing this excess cost, as brought out in Mr. Stimson's paper, but also realize that railroad accounting is necessarily so complex that it is probably impossible to devise a practical classification which would not contain some inconsistencies.

The present classification provides that the original cost of real estate for railroad purposes shall be charged to Capital Account, but makes provision, as I recollect, that, with the approval of the Commission some enhancements in value over the original cost may be capitalized. Furthermore, I believe the U. S. Bureau of Valuation, in making its valuations, is endeavoring to show the number of ties treated with zinc and separately the number treated with creosote, and I presume that the Bureau's theory is to base the final value on the total cost of the treated ties rather than to exclude the excess cost of the treatment. It seems wholly consistent to me that the excess cost should be capitalized, and that such excess should be determined wholly through the accounts of the carrier, although, as stated by Mr. Stimson, it might be necessary to devise some means of identification in order to show the kind of tie when it is removed for replacement. This is the only objectionable feature I see at this time, to capitalizing the excess cost.

It is true that there has heretofore been a steady and healthy increase in the use of treated ties, and if conditions had remained as they were two years ago, I should not have made my recommendation for a change in accounting. The Transportation Act of 1920, however, has made a change in the situation. This Act provides, I believe, that all net earnings of a railroad over 6 per cent on the valuation placed by the Interstate Commerce Commission on such railroad shall be divided so that only half of such excess can be used for dividends, etc. This provision may not be stated quite correctly, but I am sure that the excess over 6 per cent cannot be handled at the discretion of the carrier, as had been the case previously.

Suppose a road which has not been using treated ties (but where treated ties would really be an economy) is already earning just 6 per cent net on such value as the Commission may place on it. What incentive is there to starting the use of treated ties? Assuming that all conditions as to earnings. etc., would remain constant, the use of treated ties would swell the maintenance charges for some years, and thus reduce the amount which could be applied as dividends for that time. When the full saving in maintenance did accrue in the future, all of the excess over 6 per cent would have to be divided, so that the road would receive but half the benefit of the economy. The result would be the same with roads which now earn more than 6 per cent (if any) except that the net income of 6 per cent might not be reduced by the excess maintenance costs during the first few years after the change in kind of ties.

Now suppose that the excess cost of treated ties is capitalized. Then the maintenance expenses are not swelled and net income is not reduced temporarily, and in addition to that, if previously earning more than 6 per cent net, the road would be permitted to retain for dividends, etc., a greater amount than previously in the sum of 6 per cent on the additional capitalization before dividing up. It is true, of course, that the road must pay interest on this additional capitalization, if borrowed.

It seems to me that capitalizing the excess cost of treatment would be beneficial to the railroads, and by stimulating, or rather, not standing in the way of treating railroad timber, it would not only benefit the wood preservers as well, but also the general public, in that it would be an aid towards conservation of the timber supply. I do not consider that a desire to have the excess cost capitalized would be a selfish motive on the part of this Association.

I might add that the reason steel ties have not come into more general use, is, in my opinion, that they will not generally figure up to show an economy, and I do not believe permission to capitalize their excess cost has any bearing in this case.

While I have the greatest respect for Mr. Stimson's views, I can hardly agree with him in this case under present conditions.

THE PRESIDENT: Are there any other remarks on Mr. Stimson's paper?

MR. HOWSON: Mr. President, in the topic that Mr. Stimson has discussed we are confronted with the contrast between the ideal and the practical. Mr. Graham has, I think, touched on one of the practical problems. This is entirely an accounting matter. The tie is going to cost just as much whether we charge it to capital account or to operating. One of the difficulties, as I see it, is that of securing a proper basis from which to start. If we capitalize the treatment that goes into the tie it seems to me, that to be consistent, we must make some allowance to the road which uses a larger tie, or to the road which uses a better wood than some which might be selected. Likewise, if a treated tie comes out of track due to a derailment after two or three years there must be a record made of that tie as contrasted with the tie next to it, which is not treated, in order to get the renewal cost, because obviously you cannot put out a blanket order that you shall add to the capital account for all ties renewed because some treated ties will come out through accident and other causes. In other words, as a practical procedure, it seems to me that Mr. Stimson's position is correct, for with the millions of ties in service on a railroad you would introduce interminable accounting by doing other than saying a tie is a tie. It is true that this is an approximation, but as a practical procedure it seems to me that it is the only course to follow. It does penalize the road that goes into treated ties for the first few years. On the other hand, the Transportation Act has put a new light on certain of these accounting matters. Mr. Hendricks has touched on one phase of the problem. There is another phase to the problem, because the road that is earning more than six per cent, the prosperous road, will earn more than six per cent and will come under the classification that Congress had in mind when it provided for the division of the earnings over 6 per cent with the Government. As a matter of fact, those are the roads that the men interested in timber preservation prefer to deal with, because they are the roads that are able to have their timber treated. The road that earns over 6 per cent is required to divide with the Government 50-50 on that excess. Suppose it goes to treated ties, and charges them to operating. During the earlier years until it gets down to a normal basis that will tend to swell the maintenance account and will turn back into the road for the improvement of its property an operating charge or maintenance charge which otherwise would be divided 50-50 with the Government. Therefore the more prosperous roads, will, I am inclined to think, strongly favor continuing the present practice of charging the treatment to operating expenses. The only roads on which the treatment of timber will be stimulated, in my opinion, by charging the additional cost to capital account, will be those who are not able to absorb or carry the increased maintenance charge during the first few years. Those roads are not in my opinion, the best prospects for the use of treated timber under any conditions. They are the weaker roads and probably will not be able to go into treated timber in any great number for some time, because of other conditions than this purely accounting matter. I am inclined to think that if Mr. Foley, Mr. Waterman, and other railroad men have it put up to them by their management that the increased cost of treated ties is to be charged to capital account, and that it is up to them to provide the accurate records for their accounting to the Commission, they would be most ardent supporters of Mr. Stimson because they would require an office force far in excess of their total forces that they now have to run their plant, they would have to check every tie that comes out of track, whether treated or not; if it is not treated they would have to make out a report giving the total capital charge for that tie, whereas if the tie comes out is a treated tie the charge will be an operating charge. Those of you who have been confronted with railroad estimates and accounting matters know something of the details involved when you are handling ties in the millions.

THE PRESIDENT: Mr. Howson has very well put it up to you members who wish to do this, how to do it. Mr. Schnatterbeck, have you anything to add at this time?

MR. SCHNATTERBECK: Judging from the inspections I have made of some of the larger railroads that have asked for settlement with the Government in liquidation of their claims to wind up Federal control of their properties, I find that all roads do not agree on the method of accounting for their cross-ties. For instance, the Purchasing Agent will buy the ties, and on most roads the Accounting Department will assemble the costs to be attached to those ties. To the initial cost of the tie is frequently added inspection, handling and work-train service in distributing the ties, so by the time the tie gets through the accounts it will have on it maybe a half dozen or dozen charges. I remember my experience on a big Central Western road, where I met the Assistant to the President, who had the authority to approve any revaluation of the corporation's cross-tie claim against the Government. This railroad official was well informed on cross-tie matters, and questioned my appraisal of the corporation's claim, because I had added to the cost of treatment certain handling charges at the treating plant. He said: "That cost is not an operation charge. We run it in our maintenance costs, and therefore, the treatment of ties should not be charged with same." Yet on another large railroad using treated ties these handling charges were considered properly taxable on the cost of treatment.

Now that there is such a difference of opinion on accounting methods on railroads having tie-treating plants or that are under contract with commercial plants for the treatment of their ties, and recognizing the great importance of cross-ties in the material account of our railroads, it seems expedient to have a uniform method of accounting for the cost of ties. It may not matter to the railroad as a common carrier what allocation is made of the expenses incurred in obtaining the necessary cross-tie supply, but it does interest the railroad as a corporation responsible to its security-holders for an equitable return on their investment. On the other hand, the short term of the existing management of a railroad necessarily compels economy in operating costs, and this in part may explain the deplorable practice of certain department heads, anxious to lower their costs, who try to shift on others as many charges as will be taken up by those departments. This does not seem fair.

You will find in going over the railroads that opinions differ even on established customs. It depends entirely upon the official to whom you are talking. If he is a man in charge of a treating plant he is going to try in every way to reduce the cost of treatment. He will not hesitate to take from his charges a fraction of a cent per tie treated, and put it on another department of the railroad, and insist that it belongs there and does not belong to the cost of treating ties. It requires unusual skill sometimes to attain a record low cost of treatment at the expense of another department of a railroad, and it is surprising that this branch of cost accounting has not received the universal attention it deserves.

I am very glad, therefore, that Mr. Stimson by his able paper has awakened interest in this important subject. While I was connected with the Baltimore & Ohio Railroad I had opportunity to discuss with its officials many cost problems, but I had never been so forcibly impressed with the vital importance of this subject until I was shifted out into the field as a special inspector for the United States Railroad Administration to appraise the claims of the railroads for differences in their cross-tie supply at the beginning and end of Federal control. The Department of Materials and Supplies, Division of Liquidation Claims, of the United States Railroad Administration, organized soon after the railroads were returned to their owners, is trying by careful inspection and revaluation to adjust the claims of the carriers. It is a man's job, as great in some respects as that which tested the ability of the men who created and carried on the extraordinary task of the Division of Purchases and Stores under the old regime of the United States Railroad Administration.

In my investigations for the Government I have talked to railroad presidents, vice presidents, general managers, accounting officials and their subordinates, and have never found two authorities handling competitive railroad inventories who were in agreement on common theories. Consequently, the adjustment of claims for cross-ties, or other materials and supplies received and returned by the Director General of Railroads offers exceptional opportunity for a study of accounting methods of transportation corporations.

The opinion current generally, heard on my tours of inspection, is that the railroads need more money for rehabilitation and continued operation. Therefore, it is the desire of the Government to hurry the appraisal of the railroads' claims so that a prompt, reasonable settlement may be made. Unfortunately, the inventories and supporting records of many railroads make the governmental check long and tedious, and frequently the accounting data do not classify cross-ties and other materials properly, making it difficult to price the units so that a fair valuation can readily be made of the corporation's claim. The change in the cross-tie specification of all railroads during Federal operation partly explains why so many inventories have not been prepared on a comparative basis at the beginning and end of Federal control. This condition has also brought to light how incomplete are the cross-tie records on many railroads.

Some of the difficulties encountered in checking the inventories submitted for final settlement with the railroads would have been largely eliminated had the accountant and the material man cooperated more generously. The same theory is manifest in accounting for the cost of cross-ties.

Gentlemen, it is not a question of trying to cut down the cost of ties unreasonably. It is purely a question of what are the legitimate charges to attach to the tie you put in track. Whether you post the charges in the capital account, the operating account, the maintenance account or anywhere else, the charges get in the records, and the vital question is, what does that tie cost, or what did it cost?

Now, let us consider the problem of treating costs. At some plants it is the practice to charge against the tie treated, not alone the treating cost of the tie, but also the expense of unloading for seasoning, loading for treatment, and shipping out the treated tie, plus supervision and an overhead charge.

The query is, what is the proper charge to make on the treated tie. What is that tie worth in track? When you have a unified method of accounting you will find that out, but not until then. [*Applause.*]

THE PRESIDENT: Are there any other comments in connection with Mr. Stimson's report?

MR. HOWSON: There is an organization which works very closely with the Interstate Commerce Commission in accounting matters, the Association of Railway Accounting Officers, a branch of the American Railway Association. If it is the consensus of opinion that this Association feels that these charges are not properly allocated, it might be a proper matter to bring to the attention of that association, with the suggestion that a joint committee work it out.

THE PRESIDENT: How do you feel about that, gentlemen?

MR. MEYER: I second the motion.

MR. JOYCE: Mr. President, I suggest that the Executive Committee get in touch with the Accounting Association to see if there is opportunity to work with them along these lines, and if there is to appoint the necessary committee to furnish such cooperation.

THE PRESIDENT: It has been suggested that the officers for next year get in touch with that Section of the A. R. A. which has to do with accounting, and determine whether they would cooperate in the matter of proper accounting for cross ties, and the charges incident thereto.

I do not wish to hurry too fast. I wish to give plenty of opportunity for discussion of this, one of the best papers at our meeting; but if there is no further discussion we will take up the report of Subcommittee 6-3 on Car Loading.

MR. LARKIN: Mr. President, we can dispose of this paper very rapidly. The Committee has been unable to develop any new methods for loading box cars with cross-ties. The only prospect that I see of bringing out anything for the Association is to invite any suggestions or discussions of this matter to see if it is possible that any developments have occurred in this connection during the last year.

THE PRESIDENT: You will remember Mr. Larkin last year said he had a psychological report to make, relative to car loading. We hoped he would improve on that this year. Mr. Angier has developed a proposition for car loading which will be brought up in connection with material handling as I understand it. Are there any other comments on this subject? If not, we will turn to the report of Subcommittee 6-5 on Insurance. Is there anyone here to present the report on Insurance? You will remember that there was a very general feeling that there is a possibility of our getting together on more uniform charges by insurance companies on creosoted tie and timber treating plants, and as a result of this feeling there was a committee appointed to investigate this problem, and he says in a personal letter to me:

"At the time this committee was named and I accepted the chairmanship it occurred to me the subject of insurance was one of decided interest to the members of the association. I had expected that the committee would receive strong support from the members, but it would appear that this is a subject of comparatively little interest to the members as is evidenced by the fact that this committee has been unable to secure any data from members for use in its work. We received no support at all from those who were in a position to be of assistance."

He suggests that unless there is a decided feeling that this Committee be continued that the matter be dropped for the present. What is your pleasure in this matter, gentlemen?

MR. MANLEY: I move the suggestion of the Chairman be adopted, and that the subject be dropped.

MR. CURTIN: I second the motion.

THE PRESIDENT: It is moved and seconded that the question of insurance be dropped, as one of the Committee suggests, for the present. All in favor of that motion please say "aye"; opposed, "no". It is so ordered.

Next will be the report of Committee 6–6, Pressure Machinery.

REPORT OF COMMITTEE NO. 6-6—PRESSURE MACHINERY

To the Members of the American Wood Preservers' Association:

The instructions to this Committee were, "Make careful study and report on the various methods used in forcing the preservative into the wood."

In the broadest sense, these instructions could be interpreted to include any means that may be employed to obtain a greater absorption or deeper penetration of the preservative than the natural absorptive properties of the wood will effect. Under such an interpretation the Committee's assignment would include methods used in the so-called non-pressure processes, which, to some extent utilizes the pressure of the atmosphere to force the preservative into the wood. The title of the Committee, "Pressure Machinery," indicates that so broad an interpretation of the instructions was not intended and the Committee has, therefore, confined its consideration to methods used in forcing preservative into the wood by the mechanical application of pressure above atmospheric.

According to several early writers[1] on wood preservation, treatment of timbers in a closed cylinder with pressure applied to the preservative was first accomplished by Breant, a Frenchman, in 1831. It is not certain whether he succeeded in obtaining much more than atmospheric pressure; certainly little use was made of his process. The first practical use of pressure above atmospheric was made by John Bethell. His process was patented in 1838 and presumably his use of mechanically applied pressure dated from about that time. Sir William Burnett's process for treatment with zinc chloride also dates from 1838 but the method first used was by immersion in open tanks. It is uncertain when treatment in closed cylinders under pressure was first used with zinc chloride but such a plant was in operation in 1847.

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[1] "Dry Rot in Timber" by Britton (1875), and "The Preservation of Timber by the Use of Antiseptics" by Samuel Bagster Boulton (1885).

In treating operations carried on in a closed cylinder, the preservative is forced into the wood by super-atmospheric pressure created by forcing or pumping additional preservative into the treating cylinder after it has been filled with preservative fluid. The mechanical means for applying such pressure may be classed into two main groups: (1) hydraulic pumps acting directly on the preservative fluid, and (2) compressed air in auxiliary tank connected with the treating cylinder and partly filled with the preservative fluid.

From the time that pressure was first used in the Bethell and Burnett processes until the present time, the commonly employed means of creating pressure has been by the use of pumps. Compressed air was first used for this purpose in 1865. In that year Samuel Boulton patented a process for using sulphate of copper solution under pressure. The timber was submerged in the preservative in an open wooden tank, which was placed in a closed iron cylinder, an arrangement designed to prevent the preservative from injuring the cylinder. The pressure applied, according to the inventor,[1] was "that of condensed air, a condensing air pump being used capable of maintaining an effective pressure of 200 pounds to the square inch." It is not certain when compressed air in an auxiliary tank was first employed to apply pressure to preservative in the treating cylinder. It was probably first used in the United States in 1910 at the treating plant of the Chicago and North Western Railroad at Escanaba, Michigan. Previous to that, however, compressed air had been employed in Europe for several years at least.

Machinery used for creating pressure in the treating cylinder by forcing additional preservative into the cylinder may be classed as follows:

1. Pressure pumps of the following types:
    - Single and duplex horizontal piston type pumps.
    - Single and duplex outside center or end packed plunger pumps.
    - Single and duplex horizontal outside end packed plunger pumps of the pot valve type.
2. Air compressors of the following types:
    - Vertical, single or duplex high speed air compressors, steam or motor driven.
    - Single or duplex horizontal steam driven air compressors.
    - Single horizontal two stage steam driven air compressors.
    - Duplex or compound horizontal two stage steam driven air compressors.

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[1] "The Preservation of Timber." Boulton.

The manner in which the different types of pressure applying equipment is used in modern treating operations is generally understood and is therefore not here explained in detail. Briefly stated, the essential equipment is (1) a treating cylinder; (2) working tanks containing preservative; (3) means of filling treating cylinder with preservatives; and (4) means for forcing additional preservative into the treating cylinder. When pumps are used, the preservative is pumped from a working tank directly into the treating cylinder. When compressed air is employed, an auxiliary closed pressure tank is required. By maintaining such an auxiliary tank partly filled with preservative and connected with the treating cylinder, and by compressing the air in the tank, additional preservative is forced into the wood.

Methods of applying pressure and types of machines used may be considered (1) with reference to the effect on material treated and (2) from a practical operating standpoint.

The effect of pressure on material treated depends on (1) the amount of pressure, (2) its duration, and (3) the rate at which it is applied. The results contingent on these three factors will be the same regardless of the manner of applying pressure as long as the ability to control the amount of pressure is the same. As far as effect on material treated is concerned, therefore, the best method of applying pressure is that method that makes possible the closest control of the pressure curve.

In applying pressure by means of steam driven pumps, fluctuations in the steam pressure and the difficulty of controlling the speed of most types of pumps result in frequent and rapid changes of the pressure. Modern automatic steam governors and pressure regulators will overcome this difficulty to a large degree. But even when such regulating equipment is used the pressure curve will usually be rather irregular and, unless the operator is watchful, may transgress the prescribed limits. Users of the compressed air system for applying pressure claim, with some reason, that changes in the amount of pressure are less abrupt and that with the same attention on the part of the operator, the pressure will be more constant and steady and show less deviation from the curve aimed at.

In considering the methods of applying pressure from the standpoint of plant operation, the following factors are important:

1. Amount and cost of equipment required.
2. Maintenance of equipment.
3. Capacity of equipment, particularly with reference to the use of one pressure producing unit for two or more cylinders.

4. Use of equipment in operations other than the application of pressure to preservative in cylinder.
5. Power required.
6. Ease of operation and attention required.
7. Cleanliness.

The cost of equipment for applying pressure by means of pumps is less than the cost of equipment for using compressed air. Pressure pumps cost less than air compressors, less piping is necessary, and the use of a cheaper type of working tank is possible.

With less and cheaper equipment lower maintenance cost would be expected for pumping equipment than for compressed air equipment. This is true of single cylinder plants, but there is probably not a great difference in plants equipped with two or more cylinders. Where the preservative is zinc chloride or a zinc-creosote mixture, the corrosive action of the zinc results in an increase in the cost of maintaining pressure pumps but does not increase the cost of maintenance of equipment for applying pressure by compressed air.

With pressure pumps a single pressure producing unit, consisting of one pressure pump and one working tank, will serve but one cylinder. With compressed air, one air compressor will serve two or more cylinders by providing a pressure tank for each cylinder. The initial cost and maintenance per cylinder of pressure applying machinery is, therefore, reduced as the number of cylinders is increased.

Equipment for applying pressure to cylinder by compressed air can also be used for moving liquid preservatives and for forcing preservative from the treating cylinder at the end of the pressure period. It can also be used for the application of initial air pressure in treating by the Rueping process. Pressure pumps used for applying pressure have little other practical use about a treating plant. These factors should be taken into consideration in comparing the initial cost of installing pressure producing equipment.

In a single-cylinder plant a compressed air outfit for applying pressure requires more steam to operate than a pressure pump. With additional cylinders, however, this difference in steam required becomes less. In using compressed air, the amount of steam required becomes less. In using compressed air, the amount of steam required depends on the type of compressor used. The locomotive type air pump uses considerably more steam than other types of compressors and little or no use can be made of the exhaust steam. It is claimed by users of compressed air that the cost and ease of operation and the attention required is less for air equipment than for pressure pumps. An admitted advantage of compressed air is its cleanliness, the leakage of preservatives in the treating room being largely eliminated.

In a paper by Mr. F. J. Angier in the 1914 proceedings of this Association and a discussion of that paper by Mr. W. L. Bacon, the following advantages are claimed for compressed air:

1. The initial cost of installing the air pump system is more than for the hydraulic pump system, but the maintenance is less and in the long run air is more economical.
2. One air pump is ample for three cylinders, while one hydraulic pump is required for each cylinder.
3. It is possible to operate two or three cylinders with one auxiliary pressure tank but a more satisfactory arrangement is to have one tank for each cylinder, such tank serving in the triple capacity of pressure tank, measuring tank and drain tank.
4. An air pump is a necessity in plants using hydraulic pumps for blowing back solution, unless those plants are equipped with expensive underground receiving tanks.
5. It is practically impossible to maintain steady and constant pressure with the hydraulic pump while with the air pump this is easily accomplished.
6. The maintenance of one air pump is much less than three hydraulic pumps and is decidedly cleaner. With hydraulic pumps there is more machinery, tanks, piping and valves to maintain. Pumping and agitating zinc chloride solution or a zinc-creosote mixture is injurious to the pumping machinery, while such damage will be largely eliminated if these operations are performed by means of compressed air.
7. The amount of steam required to operate one air pump is not more than would be required to operate three hydraulic pumps.
8. With hydraulic pumps there is more work for the engineer and unless everything is compactly arranged he will require an assistant while with the air pump one man can easily look after the entire operation.

With reference the use of compressed air at the C. & N. W. plant where it was first used in this country, Mr. Bacon states "that the change from the force pump at Escanaba in 1910 resulted entirely satisfactory, adding much to the efficiency of treating operations and greatly cutting down the former heavy maintenance charges, doing away with frequent and costly delays, and as a whole tending to betterment and cleanliness."

That this is also true on the Baltimore and Ohio Railroad at Green Spring is attested by a statement of Mr. Angier "that after nine years service under every condition the use of compressed air has proven entirely satisfactory."

The proper control of pressure and temperature is essential.

The Committee believes that the use of governors, regulators, relief valves and other appliances for regulation of pressure is of great importance and for future work recommends the study and investigation of different types of mechanical apparatus for controlling pressure and temperature in the treating cylinder.

The Committee believes the use of gauges for determining and recording pressure in the treating cylinder is of great importance. A new type of recording instrument designed by the Forest Products Laboratory and which has proven very satisfactory is described in a paper by Mr. Geo. M. Hunt and submitted by the Committee as an appendix to this report. The Committee recommends the further study of indicating and recording guages.

E. E. ALEXANDER, *Chairman*
WM. A. CECIL
J. H. GROW
W. E. JACKSON
E. S. PARKS

APPENDIX

A NEW RECORDING INSTRUMENT

Geo. M. Hunt
In Charge Section of Wood Preservation
Forest Products Laboratory

In keeping records in treating plant operations simplicity and accuracy are of the greatest importance, whether the records pertain to an experimental treating plant or to commercial sized operations. Recording thermometers and gauges are a great advance over simple indicating instruments, and the almost universal use of recording instruments in treating plants is evidence of their usefulness.

Most of the recording instruments used by wood preserving plants have circular charts, good for 24 hours, and separate charts are used for temperature, vacuum, and pressure. Seven-day charts are, of course, available, but I do not believe they are commonly used in treating plants to show cylinder conditions. When 24-hour charts are used part of the record of a run may appear on one chart and part on another, especially in treatments which require more than 24 hours. This may be avoided by leaving the charts on more than 24 hours, but confusion is likely to result.

A more important disadvantage of the present type of instruments is the fact that in order to keep a record of the treatment it is necessary to retain three charts, circular in form and inconvenient to file. When it is desired to learn from the records the conditions which existed in the cylinder at a given time it is neces-

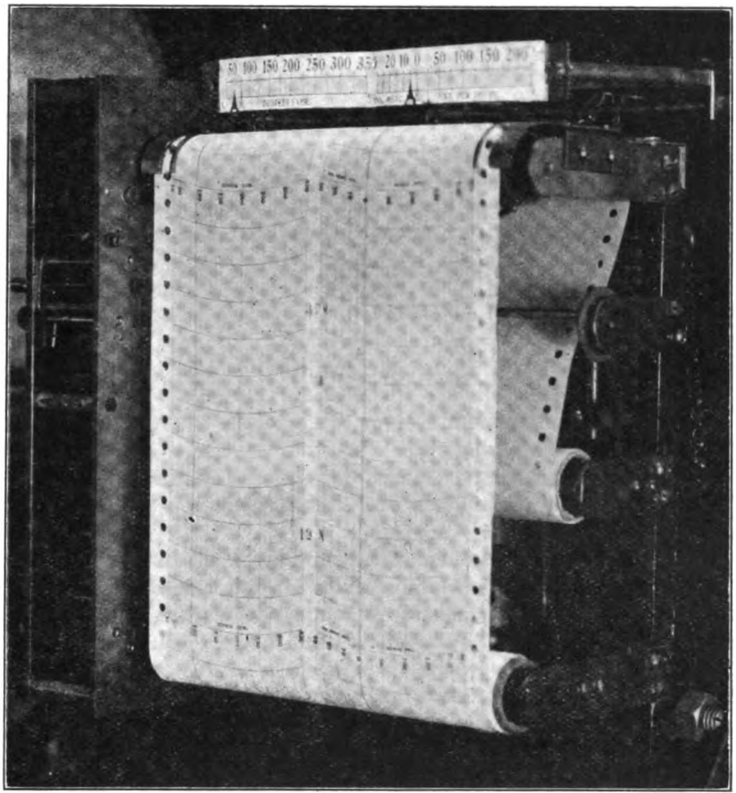


Fig. 1. Temperature, pressure, and vacuum recording gauge in use at the Forest Products Laboratory.

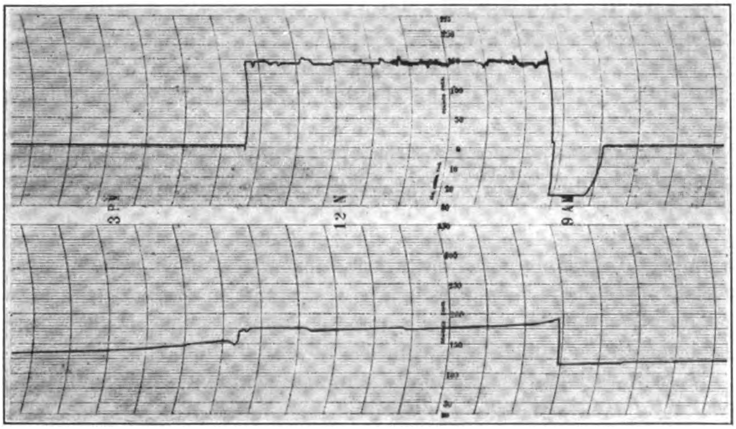


Fig. 2. A typical record made by the combined temperature pressure and vacuum recording gauge.

sary to refer to two or three charts, which is inconvenient and opens the way to errors.

With these considerations in view, the Forest Products Laboratory in 1916 asked a well-known gauge manufacturer to make, on special order, a recording instrument which would record temperature, pressure, and vacuum on one chart. After considerable correspondence and a trip to the factory the instrument shown in figure 1 was produced. This instrument uses a chart, as shown in figure 2, which will make a continuous record at the rate of one inch per hour for any desired time up to 45 days. From this record one can tell at a glance the conditions which existed in the cylinder at any time during the treating period.

The pressure and vacuum records are made by the same pen, and the mechanism which operates this pen is necessarily so constructed that it cannot be injured by either pressure or vacuum. This is a distinct advantage over some kinds of pressure and vacuum gauges in use.

This instrument is connected to our largest treating cylinder. It has been used to a considerable extent in our experimental work during the past year and has been found very satisfactory. Other recording or indicating thermometers and gauges are used on this cylinder only when the work is of such a nature that especially accurate records are needed. For all ordinary work no additional gauge is required.

While this instrument is not considered the last word in recording gauges, we feel that it is a distinct advance, and makes available to treating plant operators and inspectors a better record than has previously been possible. A further advance, which has not as yet been found practicable, would be to have on the same chart, along with the temperature, pressure, and vacuum records, a continuous record of the height of the treating solution in the working tanks. With this addition one would have a fairly complete record of the treatment in the simplest and most convenient form.

MR. ALEXANDER: I move the report of Committee 6–6 be accepted as information.

MR. WATERMAN: I second the motion.

THE PRESIDENT: It is moved and seconded that the report of Committee 6–6 be accepted as information. It is now open for discussion. Are there any questions? If not, all in favor of the motion as given please say "aye"; opposed, a like sign. It is so ordered and the committee is excused with our thanks.

The next will be the report of Committee 6–2, on Adzing, Boring and Perforating Layouts.

REPORT OF COMMITTEE NO. 6-2—ADZING, BORING AND INCISING LAYOUTS

To the members of the American Wood-Preservers' Association:

Tie adzing, boring, and perforating layouts are of two classes, portable and stationary. Portable outfits are arranged to be taken into the tie yard where ties are machined before they are loaded into the tram cars and taken to the retorts. They are also used out along the right of way where ties are accumulated in small quantities only, but it is desired that they be machined. Stationary outfits are erected on concrete foundations in permanent buildings within the tie yard and trains of loaded tram cars enroute from the tie-stacking yard to the retort house are side-tracked, pass through the tie adzing mill and the ties machined.

Advantages of either type are peculiar to the local conditions under which they must operate. In general, the portable arrangement is less expensive; the operation costs practically the same, but the stationary type is capable of greater output. Railroad companies wishing to furnish machines for use in commercial yards somewhat favor the portable type since it can easily be removed at the completion of the contract. Practically all concerns having permanent tie yards install stationary machines.

The equipment consists of independent machines for adzing, boring, trimming, branding and incising cross ties, together with auxiliary equipment, including means for handling ties, shavings and refuse removal systems, tool room outfits and power plants. Machines are to be had so arranged that any one or more of the operations may be provided for in either the portable or stationary layouts without the necessity of making the complete installation. Since it is more vital that southern pine ties be trimmed than most other woods, there are many localities where the trim saw is not considered. Some roads do not require branding, and this device is quite frequently omitted. Since only certain refactory woods must be incised this machine is not considered nearly so often as the others. Practically all now interested in railroad cross ties concede that they should be adzed and bored. This pair of machines thus becomes the first thought in connection with a mill for machining ties.

Figure 1 shows a portable adzing and boring machine placed in a tie yard equipped with a shingle tram car track between the tie piles. In this case a 50-foot box car houses the adzing machine, the boring machine, a gasoline engine power plant, a tool room outfit, a shavings exhaust system, in- and out-feed tie conveyors, and a self-propelling mechanism through the use of which it can be moved about the yard.

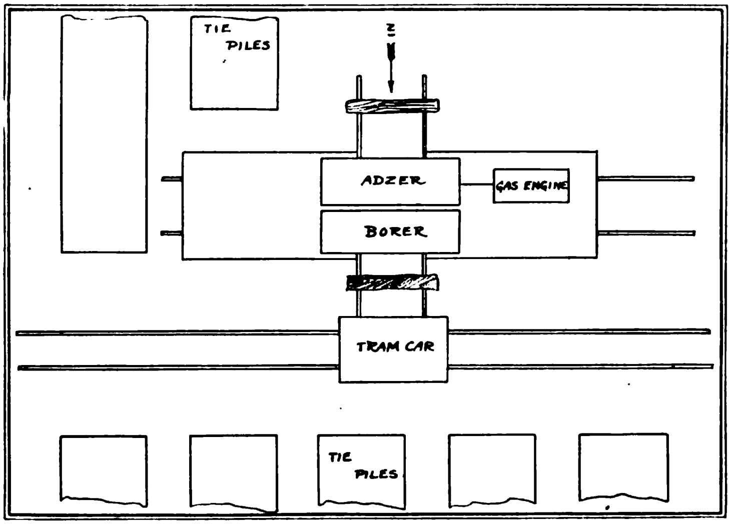


FIG. 1

The car is placed on short sections of temporary rail located alongside of the tram car track. Ties are removed from the piles ahead of the machinery car and placed by hand upon the in-feed conveyors leading to the machines. The conveyors carry the ties up into the car and deliver them to the adzing machine where they are automatically adzed and passed to the boring machine. This machine is also automatic in its action and delivers the ties to the out-feed conveyors that feed them into the out-going tram car. Trains of loaded tram cars are thus made up for the retorts practically the same as though the ties were not machined.

The branding device may be added to this car with no change in the machinery arrangement, the method of operation or the number of men employed. As the tie piles in the immediate vicinity are taken away, the track sections on which the car is mounted are moved ahead and the car proceeds down the yard, machining all ties in that section.

Details that must be considered in connection with this type of installation are the disposal of the refuse and means of moving the loaded tram car. The most standard method of removing the shavings is to blow them by fan into a box car on some near by track. The box car is switched to the power house when filled and the shavings burned. To aid in moving the tram car without cessation of operation an accumulating device is provided on the out-feed conveyors by which the flow of ties may be retarded until the loaded tram car is taken away and an empty one put in its place. The portable machines are sometimes fitted with rope hauls by which the tram cars are removed and they are sometimes drawn by a horse.

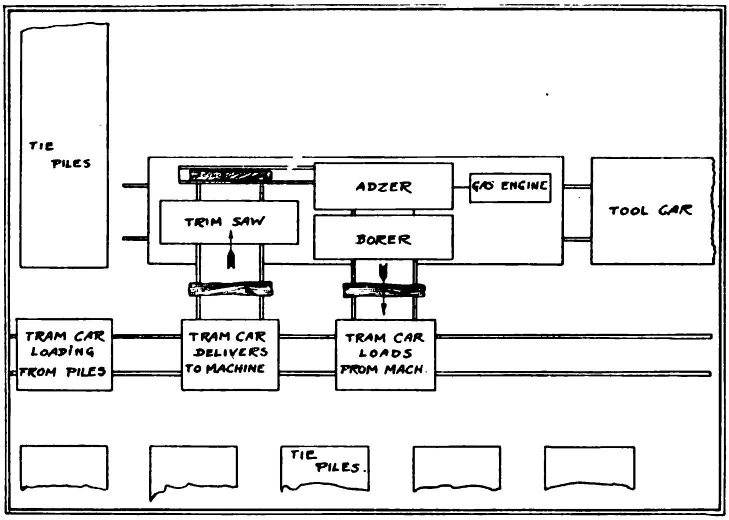

TIE PILES
ADZER
GAS ENGINE
TOOL CAR
TRIM SAW
BORER
TRAM CAR LOADING FROM PILES
TRAM CAR DELIVERS TO MACHINE
TRAM CAR LOADS FROM MACH.
TIE PILES.

FIG. 2

Figure 2 shows a more complete portable installation which is arranged to include the trim saw as well as the adzer and borer, and it may also be had either with or without the brander. In this type the tram cars are usually loaded ahead of the tie machining car and ties brought to the car in this manner. This is not, however, necessary, for they can be taken from the tie piles and placed on the in-feed conveyors, where they will pass through automatically the same as in the more simplified arrangement shown in Figure 1. If the tram cars are loaded by hand and ties thus delivered to the machinery car, then the latter becomes more nearly a stationary outfit and is not moved after being once located in the yard. If ties are to be delivered directly from the tie piles on to the in-feed conveyors of the machine, it is obviously necessary that the tie machining car proceed about the yard on temporary or permanent tracks, as described in connection with Figure 1.

The car here shown is complete with machines for all operations except that of incising. A 50-foot car will contain trim saw, adzer, borer and brander and its power plant, which may be either a gasoline engine or electric motor, but this is not large enough to also include the tool room machines, and for this reason a small auxiliary tool car must also be provided. This is usually a 36-foot car of light construction.

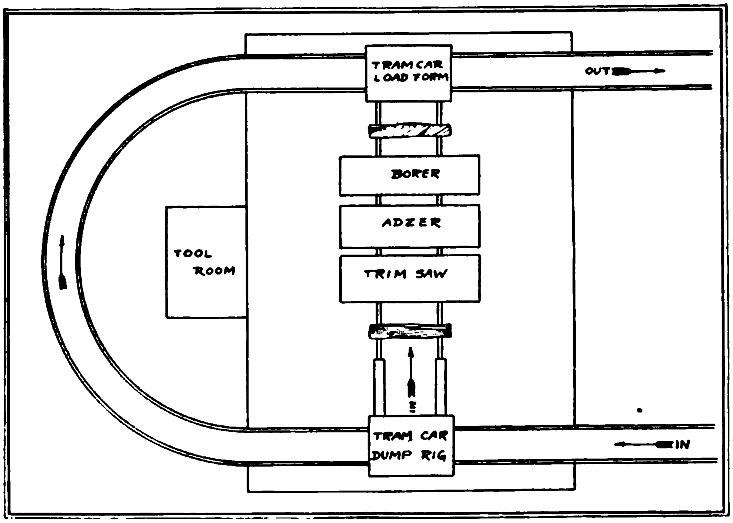


FIG. 3

In the operation of this machine, the ties enter and leave the same side of the car. They are delivered through the trim saw to an automatic end-wise transfer, which passes them to the adzing machine, from where they are fed through the borer and the brander to the out-feed conveyors that deliver them to the tram cars for further treatment. This type of machine is provided with same form of refuse removal and tram car moving devices as the standard tie, adzing and boring portable car.

Figure 3 outlines the best known arrangement of stationary machines. This illustrates the standard type of building about 36 feet wide by 67 feet long, in which are located the trim saw, adzer, borer and brander with their auxiliary devices.

Loaded tram cars enter the mill on a tram track provided with 1½% downward pitch that their progress may be by gravity. They are halted in front of the machines, where ties are elevated from them by the tram car dumping rig. From this point the empty tram cars are passed around the circular track to the rear side of the machine for re-loading. This movement may be accomplished as well through the use of two turn-tables at the rear side of the mill, except for the fact that turn-tables are not generally considered as practical in operation as the circular track.

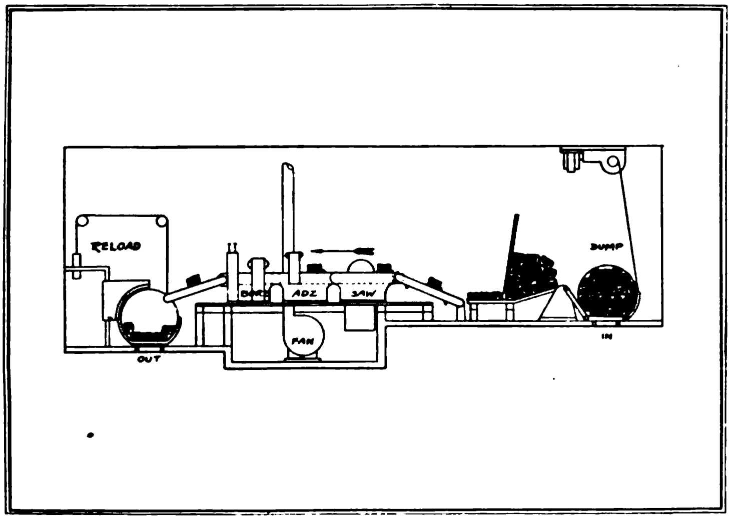


FIG. 4

Ties pass from the skiways beneath the tram car dumping device up to the conveyors and through the trim saw, adzer, borer and brander, out upon the out-feed conveyors and into the out-going tram car entirely automatic. A loading form placed to the rear of the out-going tram car provides an easy method of loading out-going trams to the true bale form. A tool room is generally fitted up in a lean-to at the side of the main building within the space surrounded by the circular track. The crew for the operation of an adzing mill of this character consists of a foreman and his assistant, two men at the in-feed end of the machine, two men at the out-feed end of the machine, and two extra men for removing and replacing bales and handling tram cars.

Figure 4 is an outline giving a sectional side elevation of the arrangement shown in Figure 3. The in-coming tram with its dumping rig fitted up with an over-head electric hoist, the load of ties deposited on the skidways and the general machine arrangement are very clearly shown. Beneath the machine can be seen the block conveyor and the shavings exhaust fan and piping for removing the refuse, and beyond the machine the outgoing tram with its loading form, are clearly illustrated.

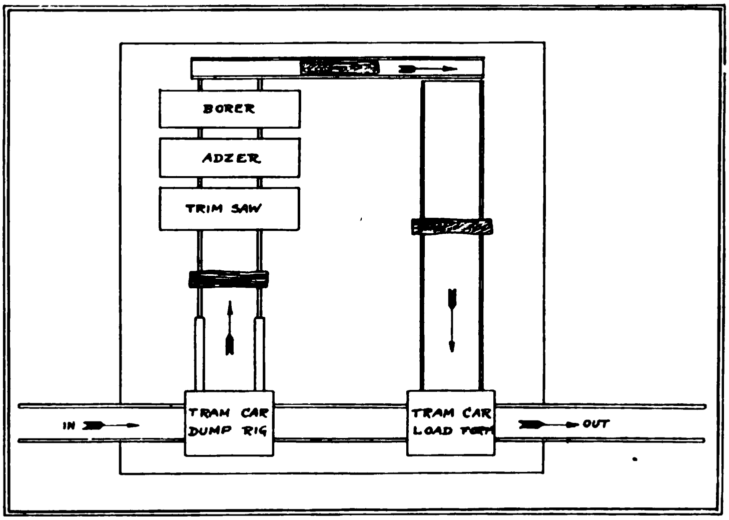


FIG. 5

Figure 5 covers an arrangement of the same machine shown in Figure 3, whereby the circular return tram track is dispensed with. In this the loaded tram cars enter the mill, the ties are dumped and passed through the machines in the same manner as shown on plate 3, but instead of proceeding from the machine to the out-going tram car by conveyors working in the same direction, they are passed end-wise on an automatic transfer to conveyor that deliver them back across the mill to the same track on which they entered.

The loading form is here located, and they are delivered by either gravity or power driven conveyors into it, loaded and disposed of the same as shown in Figure 3, except that they enter and leave the mill on the same track. Local conditions sometimes demand an arrangement of this sort and in some ways it is better than the circular track for the principal reason that the movement of the tram cars from their incoming to their out-going positions is much shorter, over a straight track, and neither they nor their loose bales require as much labor in moving. The arrangement shown in Figure 3 calls for a building about 36 feet wide by 67 feet long, while this calls for a building approximately 50 feet wide by 55 feet long. The omission of the trim saw in either of these plans decreases the length of the building about 7 feet.

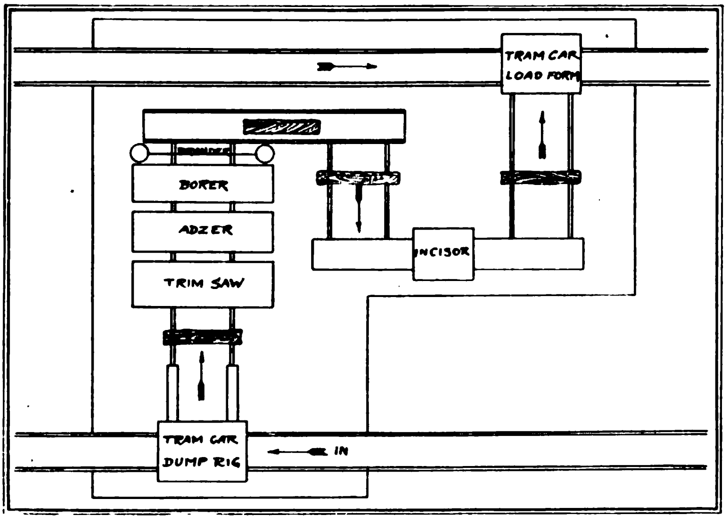


FIG. 6

Figure 6 illustrates the standard type of stationary tie adzing and boring machine with the incising machine added. In this, ties enter the mill and proceed through the trim saw, adzer, borer and brander as on Figures 3, 4 and 5. After leaving the brander they pass end-wise over live rolls to a cross conveyor that delivers them to the incising machine. This forms an accumulating point between the automatic adzing and boring machines and the incisor, making it unnecessary that the latter work in exact time with the other machines. From the incisor they proceed by out-feed conveyors to the tram car with its loading form placed on the out-going track, which is connected to the in-coming track outside of the mill by circular formation.

In this arrangement the delivery from the adzing and boring machine is by live rolls, from the live rolls to the incisor by gravity conveyors; by screw rolls back of the incising machine to the standard power driven out-feed conveyor. This arrangement demands a building approximately 58 feet wide cross-ways, of the tram tracks and of L shape having the two wings of the L approximately 26 feet wide.

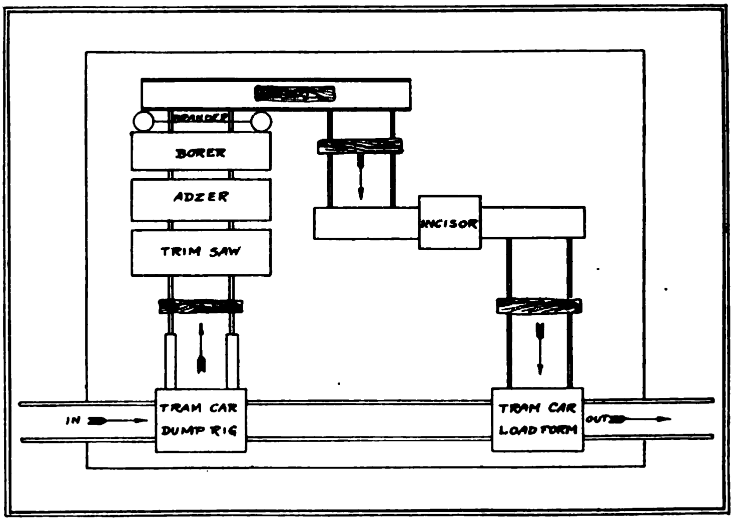


FIG. 7

Figure 7 shows a machine arrangement the same as Figure 6 except that in this we have reverted to the single track service. The trams thus enter and leave on the same track which, as has been stated, reduces the labor of handling the empty trams and bales. This causes us to return to the rectangular shape of building, which would be approximately 46 feet by 62 feet. The single track mill has one more advantage in that it lends itself more readily to places where more than a single mill is installed.

Figure 8 shows a multiple of adzing mills of the single tram track type. In this the tram trunk line serves all of the mills. The empty trams leave each mill, passing over a turn table at the rear, from which they are switched over curves to the return main trunk line going toward the retort house. It must be considered that all loaded and empty trams are to move into, through and from the adzing mills by gravity. For this reason a 1½ per cent grade is provided in the tram track. This grade and subsequent gravity movement is readily cared for in an arrangement as here shown.

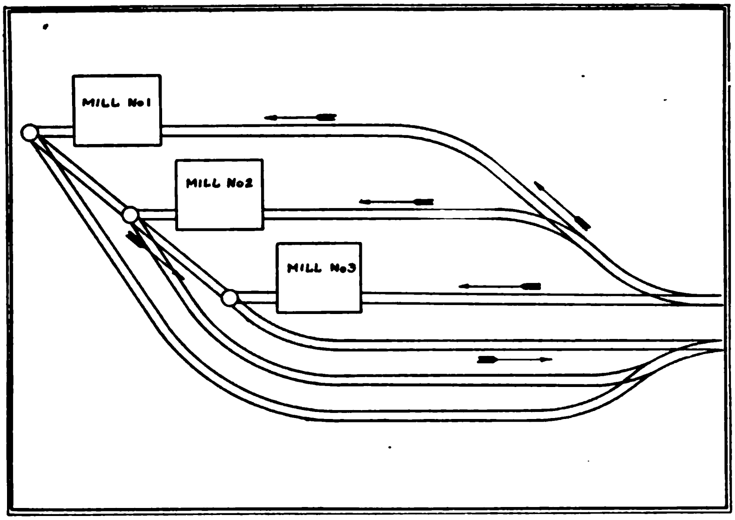


FIG. 8

D. W. Edwards, *Chairman*
C. L. Osborn
R. H. Moore
J. H. Curry

The President: Are there any questions to be asked of Mr. Edwards? A motion to accept the report as information is in order.

Mr. Angier: Mr. Chairman, I move the acceptance of Mr. Edwards' report as information.

Mr. Waterman: I second the motion.

The President: It is moved and seconded that the report of the Committee be accepted as information. Are there any remarks? All in favor of that motion will say "aye"; opposed, a like sign. It is so ordered.

Next will be the report of Committee 6-7, Material Handling.

REPORT OF COMMITTEE NO. 6-7—MATERIAL HANDLING

To the Members of the American Wood-Preservers' Association:

The instructions of the executive committee to Committee 6-7 were, "Develop improved methods for handling lumber and ties."

A review of all the varied industries whose products are of a bulky nature and of considerable tonnage indicates that there has probably been less effort and energy devoted towards methods and equipment making for economical handling in the industry pertaining to lumber and forest products than in any other industry. This condition is not due to lack of progressiveness on the part of the lumber producer, but it is due to the nature of the raw material or logs from which the lumber is produced.

Beginning in the forest, with the logging operation, the particular land being logged will have merchantable logs of several different species. The logs when sawed into lumber produce many different grades, and to obtain the most valuable grades in merchantable sizes without waste, so as to secure the maximum return on his log investment, the lumber producer necessarily has a large variety of sizes and grades to contend with.

The average lumber manufacturer has in stock, taking into consideration the various species of wood and various combinations of grades, length, width, and thickness, anywhere from 450 to 650 different articles, or units of merchandise to handle, and as a rule, caters to an order containing many different sizes, species, and grades—preferring an order of this kind to one of straight carloads or cargoes of some fixed size, grade, or species, as it enables him to keep his stock in a more evenly balanced condition than would otherwise be possible.

Such an order may call for comparatively few pieces of different sizes, length, and grades, and as these pieces are all comparatively light, and can readily be handled without the assistance of machinery, the system of using manual labor for this work has much in its favor.

There has, however, in the past few years, been a marked development in mechanical handling equipment for the products of the lumber manufacturers. This movement was started on the Pacific Coast where owing to the size of the trees it was possible to produce very large timbers—timbers that were too large to be handled manually. Many types of small stationary derricks and mechanical handling methods were tried. The results obtained by these were such as to stimulate interest in the mechanical handling of the entire output of the mills. Progress in this direction has not been rapid, because of the radical changes necessary in the plant arrangement and in the operating methods of the industry to obtain full advantage of the mechanical handling equipment.

One other probable reason is that very few builders of cranes and mechanical equipment having engineering organizations have given the lumberman's transportation problems any serious consideration. The lumber producer has been left to devise his own methods and equipment, which is a branch of engineering foreign to the lumber industry and a subject with which the lumberman is not familiar.

The familiar types of cranes for various industrial purposes are not particularly well adapted for handling lumber and forest products, owing to the length and bulky size of these products and the awkwardness encountered in handling the pieces rapidly.

The storage space required for the average size stock is of such a great area that the capital investment in crane equipment for covering the area is necessarily high.

The Locomotive Crane.

One of the earliest types of mechanical equipment in use in lumber and timber yards was the locomotive crane with which you are all familiar. This machine met with much favor because as well as being able to lift and carry heavy loads it could also be used as a switch engine for switching cars around the timber yard. The disadvantage of this machine is its speed limitations, necessitating a large crew to develop the full possibilities of the crane.

The Monorail System.

The monorail system, which consists of an I-beam track suspended from a trestle structure, was developed. The monorail system is a fast machine and can be operated by a small crew. Its cost of installation and lack of flexibility in storage arrangement makes its use for large storage yards prohibitive. For frequent and rapid movement of material between fixed points it has many possibilities.

The Bridge Type Crane.

The bridge type crane has been used to good advantage with some changes from the standard type trolley ordinarily used on bridge type cranes. This change in the trolley of the bridge type crane consists of placing the operator's cage on the trolley instead of the bridge, and providing four-point suspension for the load.

The standard crane trolley construction as a rule provides only one hook. With the use of a single hook, considerable trouble was experienced in handling long and bulky loads, due to the load twisting and hanging in various positions, making it necessary before setting a load down, to square it up with the pile.

With the four-point suspension, four hooks, or cables, are provided—these being fastened to four different points of various type carriers, and being spread to such an extent that no particular effort need be exercised in balancing the load. The crane can also travel rapidly along the length of the crane runway, and the trolley may be operated along the length of the bridge without having the load twist out of position and also without dangerous swinging of the load.

The bridge type crane has the advantage over the monorail and locomotive crane, of permitting every square foot of area between the crane runway rails to be used as storage space.

Bridge type cranes of 10-ton capacity having a span of 125 feet, a bridge travel of 350 feet per minute, loaded, and a hoisting speed of 60 feet per minute, have been developed and used to good advantage in lumber and timber yards.

The Colby-Sampson Crane.

One type of crane that is meeting with much success in the Pacific Northwest for handling lumber and timber is a type of crane known as the Colby-Sampson crane. This is a modification of the portal pier type crane. The portal travels on a track having 20-foot rail centers. The portal is usually constructed in such a manner that cars and locomotives can pass through the portal on a standard gauge track laid between the rails of the crane track. A long horizontal stiff boom is mounted on a structure which contains all of the operating machinery, and is arranged to rotate on top of the portal structure. These cranes are built in several sizes having booms 60, 76 and 90 feet long, and can be rotated in complete circles in either direction. On the boom is mounted a carrier, for the hoisting line, which can travel backward and forward throughout the length of the boom. With this type of crane, areas 120, 152 and 180 feet wide, and the length of the crane track can be covered. These machines have been built and equipped with steam boilers and engines, and gas engines, as a source of power, although the most popular type is the electrically driven crane.

The most popular size of crane of this type has been one having a capacity of 8,000 pounds, at a radius of 76 feet, with a distance of 50 feet from track to the under side of the boom.

The standard speeds for this size crane are: travel 200 feet per minute, hoisting 60 feet per minute, racking carriage on boom 80 feet per minute, rotation one complete circle per minute.

The Cantilever Crane.

Many special types of cranes have been developed to meet the individual needs of some particular operation—one of the notable installations of this kind being the cantilever crane.

One of the prominent producers of the West now has in operation four cantilever cranes. This company originally started with the installation of one crane. As their experience has taught them, they have varied the design of these cranes somewhat, the principal changes being to increase the size of the cranes and make improvements in some of the mechanical features. The last crane built and installed by this company has a span, at right angles to the track, of 202 feet, and a height to the underside of the cantilever arm of 37 feet. This crane operates on a runway 2,400 feet long. To reduce the amount of travel on the runway, the crane is provided with a platform in the portal of the crane, on which 11 packages or units can be placed. The standard package adopted by this company averages about 2,700 board feet—making the lumber carrying capacity of the crane when traveling on the runway, approximately 30,000 board feet. The speed of this crane when traveling is 350 feet per minute, the hoisting speed loaded is 42 feet per minute, and the speed of the carrier in traversing the cantilever arm is 250 feet per minute.

This crane is arranged with a carrier or hook particularly adapted for handling units of the adopted size. The mechanical and control features of the crane are so arranged that the operator travels throughout the length of the cantilever arm with the hoist and hook or carrier. In this way, he is in a position to readily see the loads to be handled and manipulate the crane to the best advantage. This crane is electrically driven, and so arranged that the operator can control all movements of the crane, from any particular location of the cab on the cantilever arm.

The function of this crane is to take material from an assembly point near the mill, where the lumber is piled into units with stickers between layers, to permit drying, and deliver the units in place in the drying yard. It is also used to take lumber from the drying yard to the planing mill and loading platform. This crane handles from 250,000 to 300,000 board feet per nine-hour day. The crew is composed of one man.

The "working" storage capacity within reach of this crane is

28,000,000 board feet. In this instance "working" storage capacity allows for necessary vacant spaces in the yard, and partially full piles.

Other Types.

Several other installations of different types, consisting of cranes designed to meet certain conditions in conjunction with the monorail system, have been developed for particular installations, many of which have proven economical and a few of which have been abandoned.

Selection of Material Handling Equipment.

The greatest problem as affecting the lumber producer is the great diversity in sizes, grades, and species, as well as the large areas required for properly storing a stock of lumber to permit careful and proper drying conditions. The user of timber and forest products usually deals in a pretty well-defined class of these forest products and does not therefore have many sizes to contend with, as compared with the lumberman. His problem in the selection of equipment and organization of a plant for mechanically handling this material is greatly simplified.

As an illustration, we will assume a commercial treating plant. The bulk of this business probably represents railroad cross ties and piling. Probably the next in proportion are bridge timbers and structural timbers, and then the smaller types of lumber. Knowing with a fair degree of accuracy, the approximate proportions of the various materials to be handled, taking into account the land available for the location of a plant, a selection of the type of apparatus best suited to operating conditions can be made.

One of the most important features of an installation of this kind is the selection of the type of hook or carrier to be used with the crane. In selecting the type of hook or carrier, the manner of piling the stock for drying and for dry or treated stock storage must be taken into account and be treated as one problem. It is possible to effect as great or a greater saving in the type of hooks used as is possible in the type of crane used. There has, apparently, been very little thought given to this feature of a crane installation for handling forest products. There have been developed some carriers which for their particular application are very economical, and the development of a hook or carrier for any condition does not present serious difficulties.

One type of a carrier is shown in figure 1. This carrier is used in connection with a bridge type crane having the trolley arranged for four-point suspension. Four hoisting cables pass through four sheaves on this carrier—one sheave being located on each corner of the carrier. The carrier consists of a frame work from which is suspended four "L" shaped arms. These arms are driven through gearing by a small motor mounted in the carrier frame, and controlled from the crane cab by the crane operator.

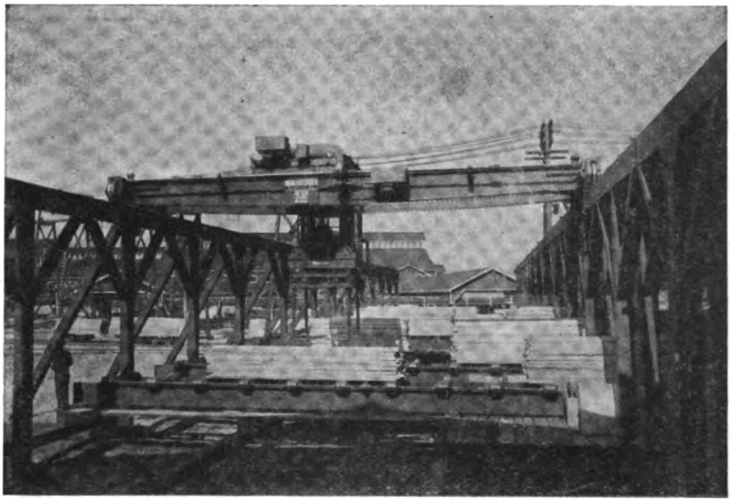


Fig. 1. Bridge type crane.

The arms as shown in this illustration are in the "open position" and when the carrier is lowered over a unit of lumber, the arms straddle the load—two arms on each side of the load. When the carrier has been lowered a sufficient distance so that the horizontal parts of these arms are below the bottom of the load, the operator closes the circuit which causes the motor to turn the horizontal part of these arms under the load. The arms are then in such a position that when the carrier is raised the horizontal portion of the arms lift and carry the load. In depositing the load, the operation is reversed. The load is lowered in this particular instance onto live rolls but may be set down on bunks, or by the use of 4-inch cross pieces on top of another load to provide space for the horizontal part of the arm, may be placed on top of another unit. Then, by closing a circuit of the motor controlling the arms, the arms return to a position as shown in this illustration, and the carrier can be raised leaving the load in position. The particular crane shown in this illustration has on many occasions handled more than 600,000 board feet of lumber per day, taking same off small industrial cars and placing the lumber on live rolls leading into the planing mill or piling the units up in storage piles.

The company has adopted this method for handling lumber in its largest distribution yards. A standard unit of lumber is 4 feet wide and 4 feet high and of the various lengths of lumber that are carried in stock; 6 units high has been adopted as standard piles. Allowing for foundations under the units and the spaces between units for the carrier arms makes the lumber piles 29 feet high. No trouble has been experienced in maintaining alignment in these piles so as to prevent the piles from tipping over or leaning to such an extent that the operator had any difficulty in placing or removing units.

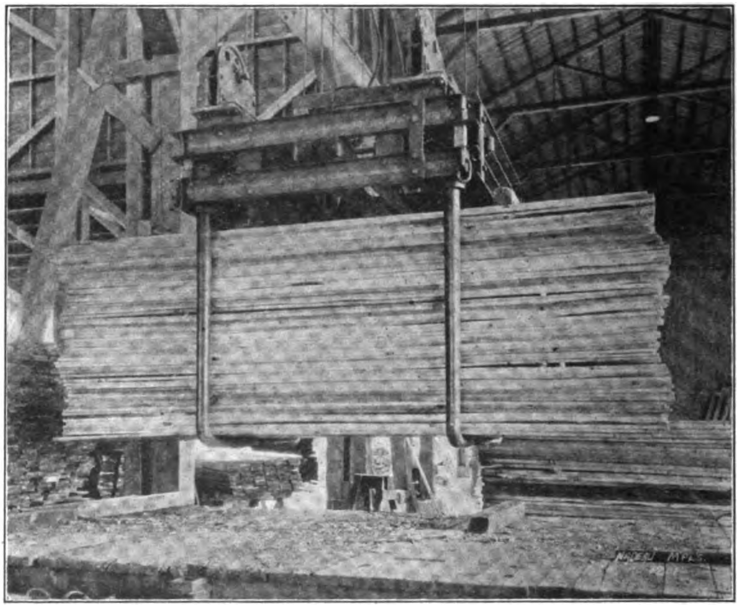


Fig. 2. Carrier of bridge type crane lifting load of lumber off flat car.

Figure 2 is a close-up view of this carrier lifting a load of lumber off a flat car. The two pieces of 4x4 lying crosswise on top of the load are placed there to form the spacers for placing the next unit on top of the unit shown. At this particular plant all lumber that can be shipped on flat cars, if the shipments originate within 200 miles of the plant, are loaded in units. For longer shipments the loss in holding capacity of the car due to the spacers does not warrant loading in units.

A modification of this carrier is shown in figure 3. This carrier has as an added feature over the carrier shown in figure 1, of a turn-table arrangement whereby the operator as well as opening and closing the carrier, can also completely rotate the load and place it at any desired position in relation to the travel of the crane.

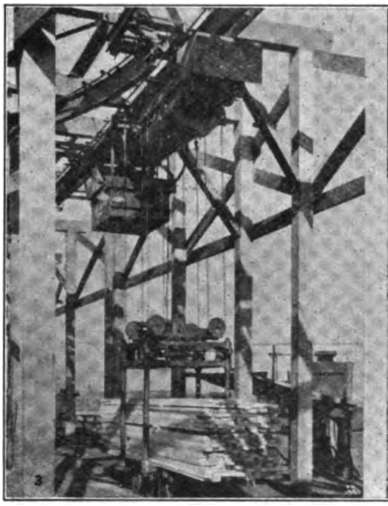


Fig. 3. Monorail system with turn-table type of carrier.

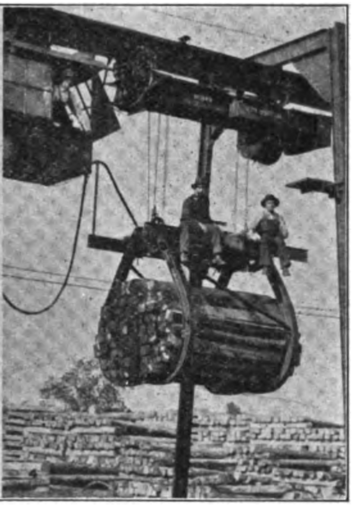
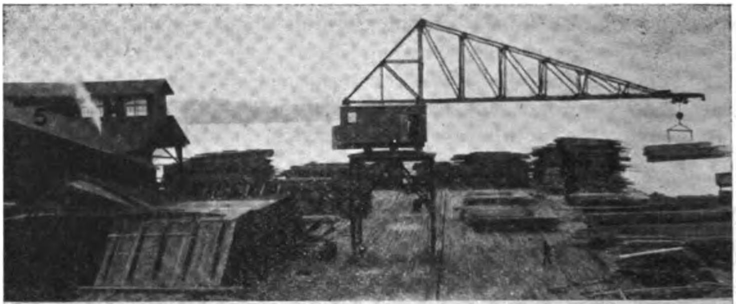
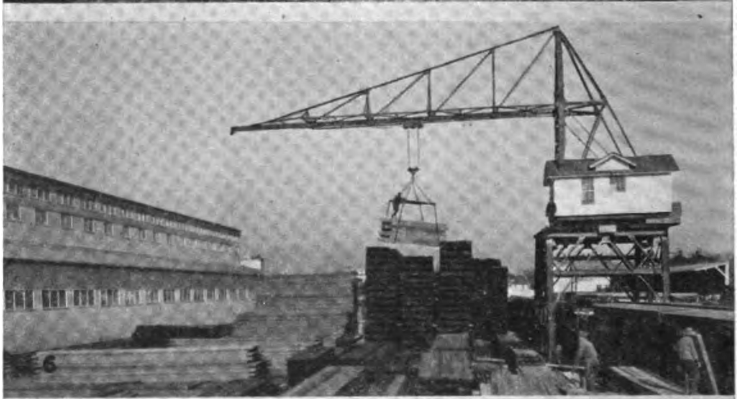


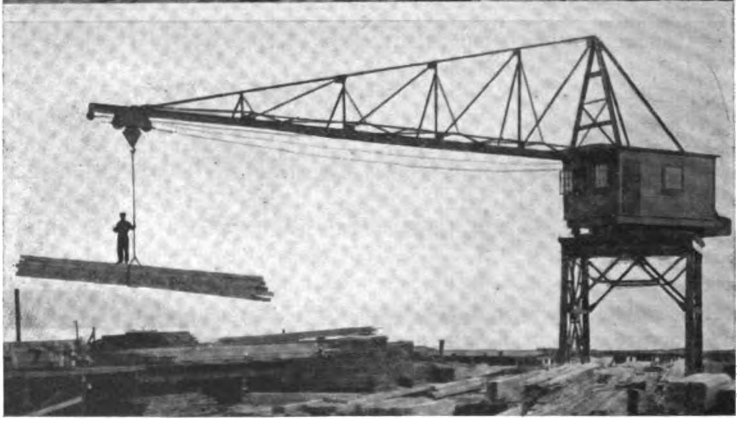
Fig. 4. Carrier for handling cross ties.

Figure 4 illustrates a type of carrier developed for handling railroad cross ties. The operation of this carrier is somewhat similar to the operation of a clam-shell bucket. This type of carrier could be arranged to be used with any type of crane.

Figures 5 and 6 show two modifications of the ordinary sling carrier. Particular attention is invited to figure 6. It will be noted upon looking at the ends of the piles of lumber and timber that alternate portions project beyond the neighboring courses. The height of the lumber piles in this yard are 30 feet above the ground. No space between units is provided in these piles. When it is desired to remove any lumber from any one pile, the "sling

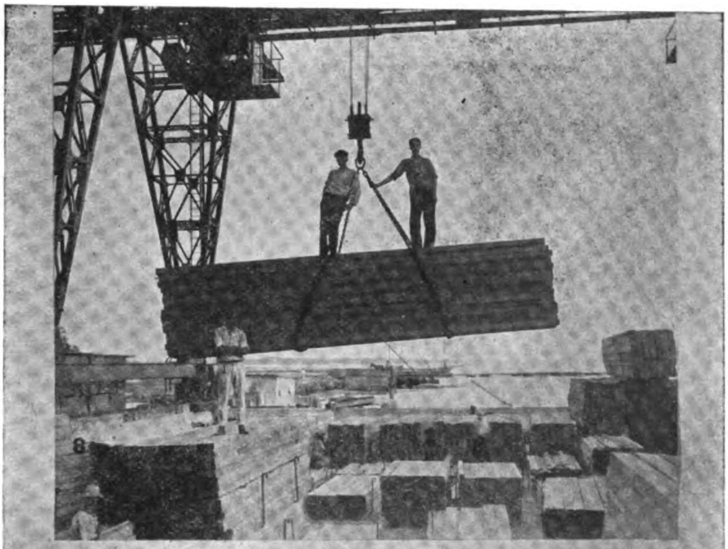






Figs. 5 and 6. Modifications of ordinary sling carrier.
Fig. 7. Chain sling which distorts load and bruises lumber.

chaser," after determining how many courses to lift off the pile to obtain the required number of pieces, puts one loop of the sling under the projecting end of the desired course. The load is then raised a sufficient distance to permit of placing a block between



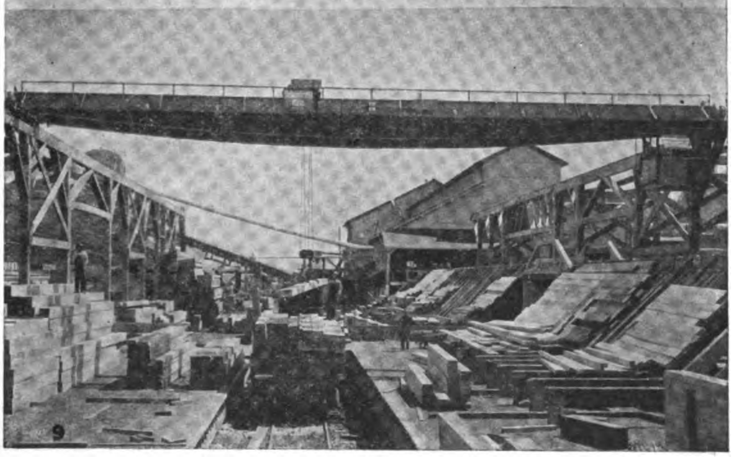


Fig. 8. Showing specially designed iron binders for handling loads.
Fig. 9. Bridge type crane at timber-loading platform of sawmill.

the pile, and that portion of which one end has been raised. The load is then lowered onto the block and the sling readjusted so as to carry the load suspended as shown in the illustration.

Figure 7 shows a load suspended from a crane with an ordinary chain sling. This system is slow, distorts the shape of the unit, badly bruises the outside courses of lumber, and has nothing to recommend it, except its low initial cost.

Figure 8 shows one type of an iron binder used for carrying loads. This type of binder and carrier was developed for intershipment of lumber between two plants owned by one company. The binders are shipped with the units and serve in keeping the units in shape during transit and in unloading them at their destinations, after which the binders are returned to the starting point.

Figure 9 illustrates a bridge type crane in use at the timber-loading platform of a sawmill. This crane has the operator's cage at one end of the bridge travel. This does not give the operator the close view of the operations that would be obtained if the operator's cage were suspended from the trolley. This crane is equipped with two-point suspension, or two lifting lines. The use of the ice tongs shown in this picture is not to be recommended

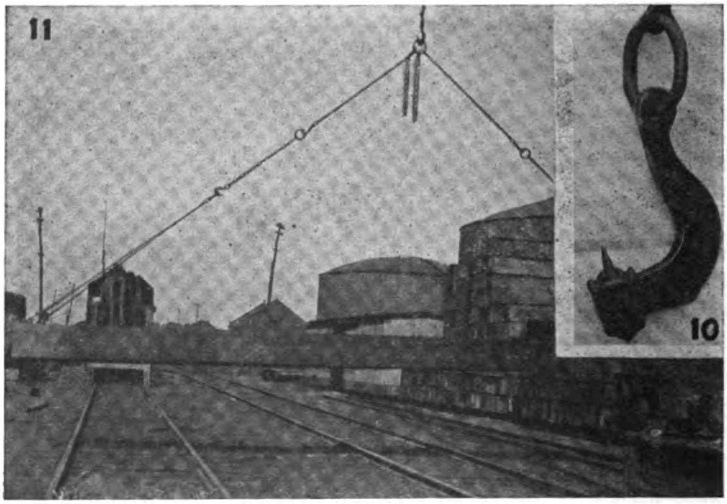
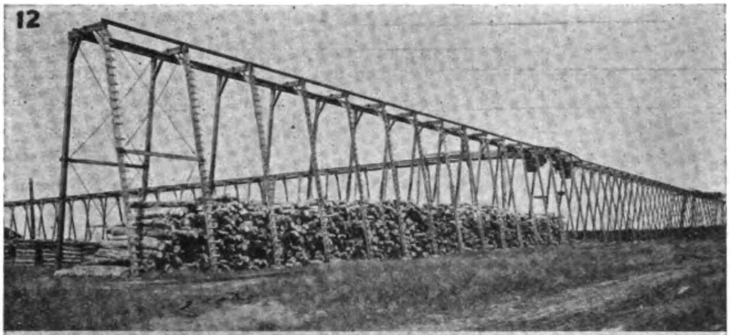
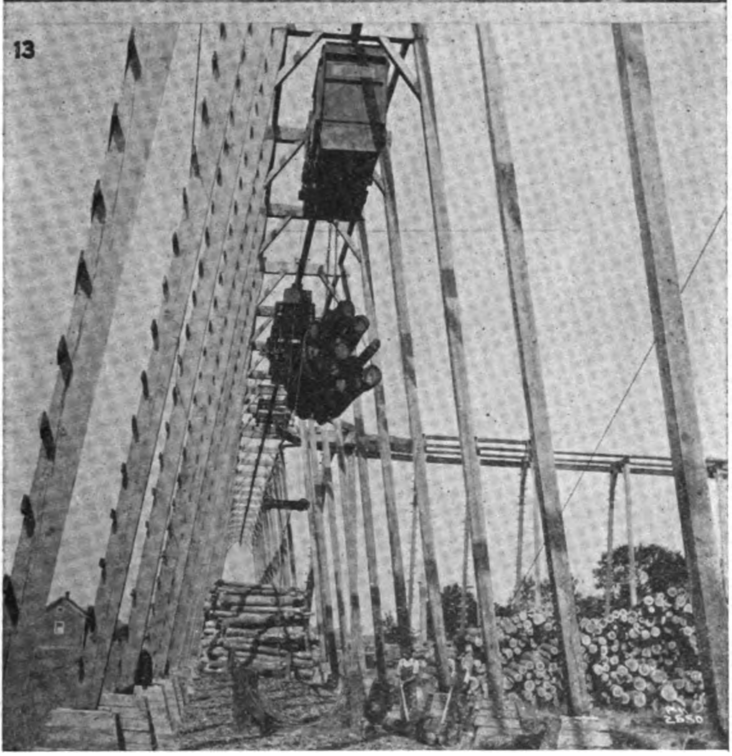


Fig. 10. Hook used in handling timbers by two ends.
Fig. 11. Hooks in use with crotch line unloading timbers from car.

Quicker dispatch with less injury to the timber could be obtained by using a stiff spreader between the two lower sheaves so as to





Figs. 12 and 13. Monorail installation for handling and storage of logs.

obtain two-point suspension, and a crotch line with hooks for attaching to the ends of the timbers.

Figure 10 illustrates a type of hook for use in handling timbers by the two ends. This type of hook holds the timbers securely and is easily released when desired. It rarely injures the timbers, as the points of the hook can not enter the timber and split it. Figure 11 illustrates the hooks shown in figure 10 and a crotch line lifting two pieces of 12"x16"x36'. Note the head chain arrangement to provide for various lengths of timbers. Timbers 10 to 50 feet long are handled with only two adjustments in the length of the chains.

Figures 12 and 13 illustrate a monorail installation for the storage and handling of logs. There are possibilities in such a system, for handling railroad ties, piling, and poles.

Figure 14 represents a transportation unit that is meeting with considerable favor at some plants as a method of moving material

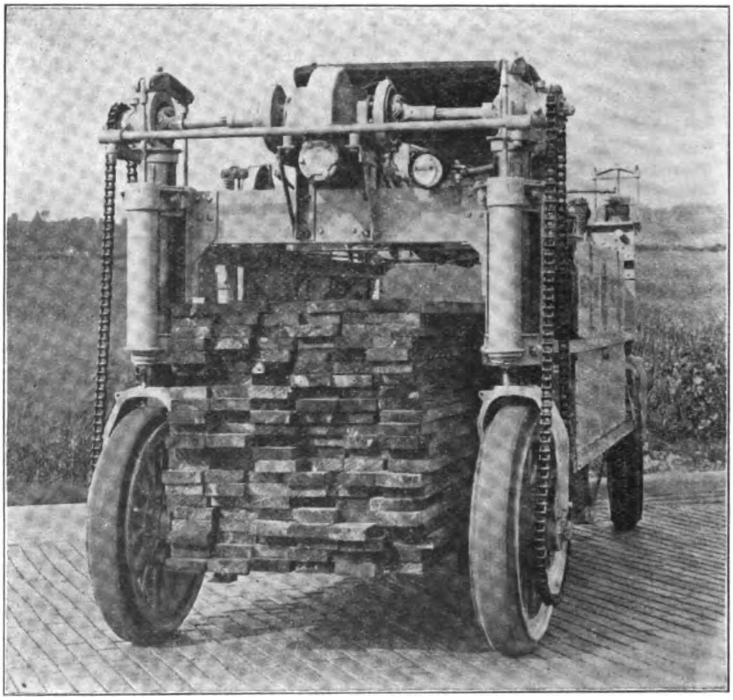


Fig. 14. An adaptable transportation unit that picks up its own load.

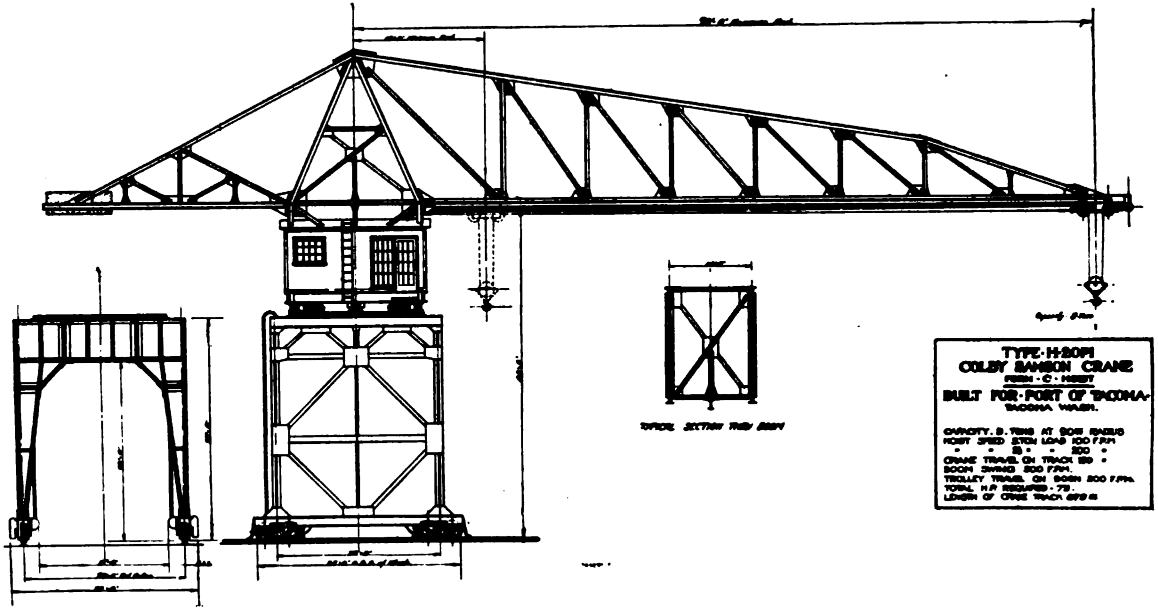

TYPE·H·20PI
COLBY SAMSON CRANE
FORM·C·HOIST
BUILT FOR·PORT OF TACOMA·
TACOMA WASH.
CAPACITY. 5·TONS AT 90 FT RADIUS
HOIST SPEED 5 TON LOAD 100 F.P.M
〃 〃 2½ 〃 〃 200 〃
CRANE TRAVEL ON TRACK 150 〃
BOOM SWING 300 F.P.M.
TROLLEY TRAVEL ON BOOM 300 F.P.M.
TOTAL H.P. REQUIRED · 75.
LENGTH OF CRANE TRACK
TYPICAL SECTION THRU BOOM

Fig. 15. Crane designed for use on docks at Port of Tacoma.

from point to point about a plant. This machine is shown carrying a load of common stock. In the use of this machine, the stock to be handled is piled in units on two cross pieces. The machine straddles the load until it is in a position over the load. Carrier arms under the control of the driver swing in and engage the cross pieces supporting the load, after which it can be raised and carried to its destination. After the load is lowered, the arms disengage from the cross pieces, and the machine is free to move away leaving the load deposited on the carrier cross pieces. Such a transportation unit must have a well planked or paved roadway

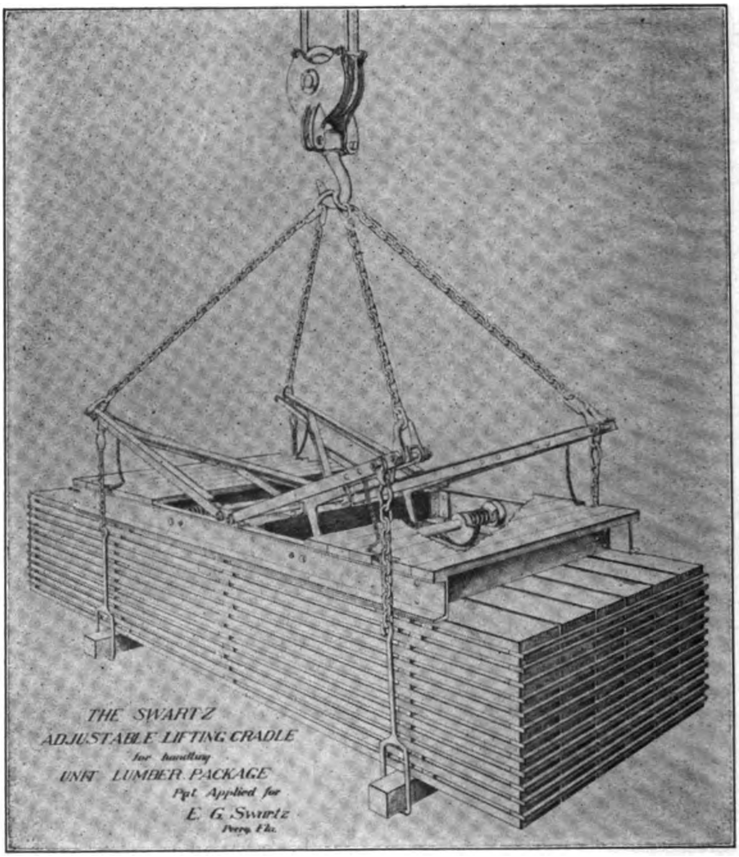
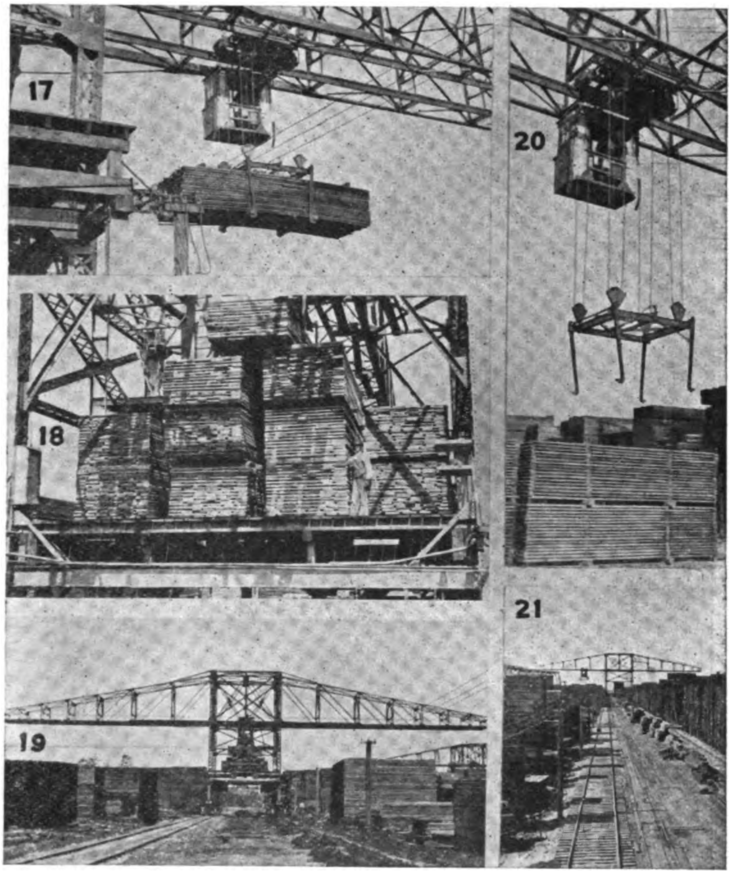


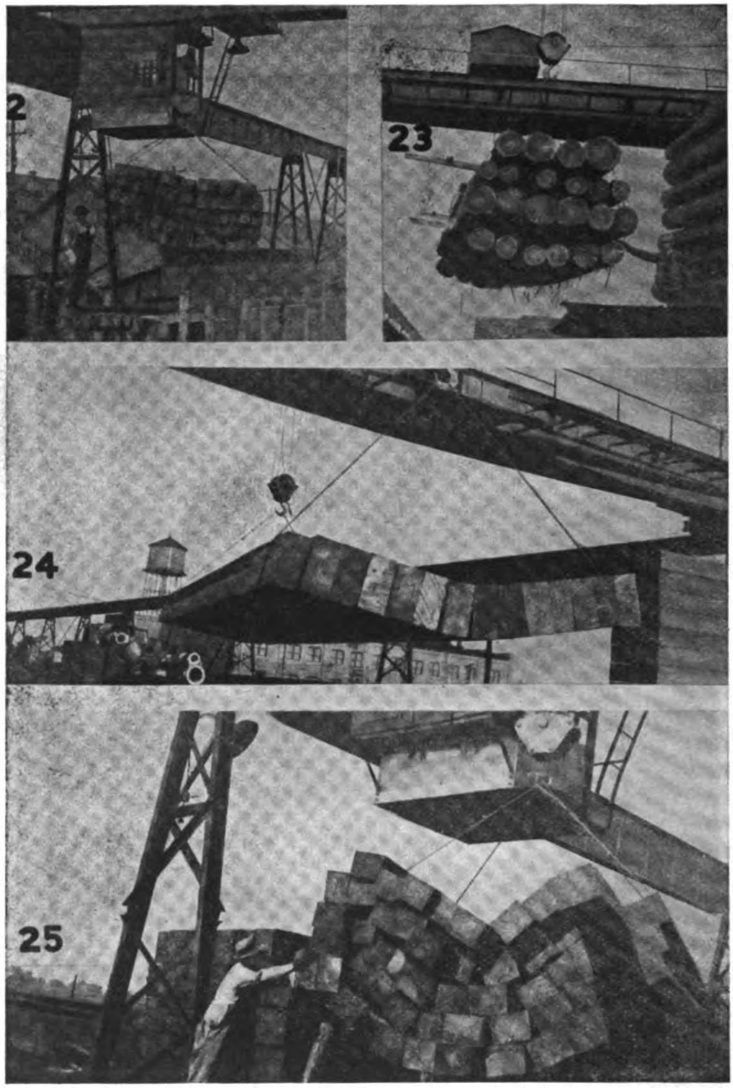
Fig. 16. A unit lumber carrier which handles load without disturbing position of boards and drying spaces.

to operate on, as the road clearance of this machine does not exceed 6 inches.

Figure 15 illustrates a crane recently installed for the Port of Tacoma for handling forest products into storage and from storage to ship's tackle for shipment. This crane has a capacity of 5 tons at a radius of 90 feet.



Figs. 17, 18, 19, 20, and 21. Views of a 202-foot span cantilever crane operated by one man and handling 300,000 feet of lumber daily. Fig. 18 shows platform in portal of crane in which 11 units can be placed. Figs. 19 and 21 show part of the 2400-foot runway.



Figs. 22, 23, 24, and 25. Views of a bridge type crane handling ties, bridge stringers, piling, etc. at the Silvis Store of the Rock Island Lines, showing use of wire rope slings, size of units, and height of piles.

Figure 16 illustrates a unit lumber carrier. The principle of this carrier is that the weight of the load gives a binding action, so that when swinging about on the hook of a crane the relative position of the boards and drying spaces is not disturbed.

Figures 17, 18, 19, 20 and 21 illustrate the 202-foot span cantilever type crane referred to earlier in this report.

Figures 22, 23, 24 and 25 illustrate the use of a bridge type crane handling material at the Silvis Store of the Rock Island Lines, showing the use of wire rope slings, the size of the units that may be handled, and the height to which the material may be piled for storage.

There are several carriers and handling methods developed and in use other than those herein referred to. Many of these are described so fully in the report of your Committee on Plant Operation in the Proceedings of 1920 as to need no further comment at this time. It is suggested that anyone interested in this subject refer to the report of that Committee as presented at the Convention in 1920.

A method of loading cross ties into stock cars has recently been developed by Mr. F. J. Angier, Vice President of this Association. This loading equipment, as shown in figure 26, consists of a high loading platform of any desired length. Right and left-hand curved chutes are fastened to the side of the platform and project into the cars. The units of ties are placed on the platforms near the chutes. The ties are then pulled down onto the chutes and slide into the cars, making the right angle turn and landing in the car in such a position as to require a minimum amount of labor inside of the car.

Layouts for Treating Plants.

Three tentative plant layouts are submitted with this report.* One layout is arranged for use with a locomotive crane; one contemplates the use of a bridge type crane; and one contemplates the use of the hammer-head type of crane.

These tentative layouts for treating plants are not submitted as ideal plant arrangements but as preliminary layouts to be used as a study, and to show graphically the manner in which a plant operation can be condensed so as to shorten all distances of travel, using smaller ground areas. In many instances the real estate occupied by a plant is comparatively high priced acreage, so the saving that may be effected in reduced acreage and trackage will

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* The tracings of these layouts are too large to reproduce satisfactorily in the printed report. If desired blueprints may be obtained from the Secretary at cost of printing.

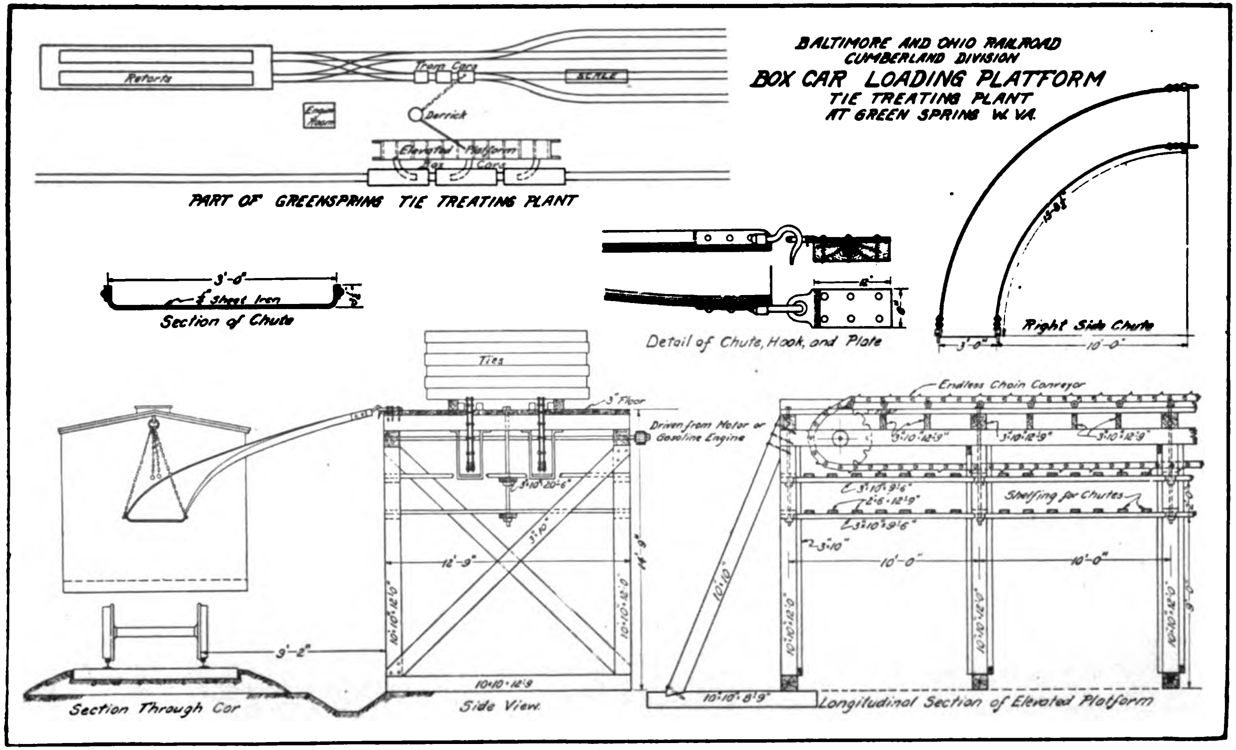

Fig. 26. Equipment used by the Baltimore and Ohio Railroad Company for loading cross ties into box cars.

go a long way towards offsetting the capital invested in handling equipment.

The layouts as presented are open to considerable criticism, for in preparing them one object in mind was to show as much equipment as possible. Then when considering an actual application or plant design, eliminate such equipment which is of least practical value to the particular plant under consideration.

One point open to criticism in the two layouts for the bridge and hammer-head type cranes is the arrangement of storage tracks and transfers at both ends of the retorts in addition to having cranes that will span the width of the retorts. Another is the tram loading provision. Many operators object to opening both ends of a retort. For some operations the advantages obtained in keeping the stock moving in one general direction offset the disadvantages of the double-ended retort.

Yards using the bridge type and hammer-head type of cranes have been laid out in which there were parallel crane runways and the cranes transferred from one runway to another by means of a transfer car usually installed at the end of the runway.

The working capacity of each of these layouts is practically the same, and will provide storage for approximately 500,000 railway ties. This working capacity depends to some extent on the climatic conditions prevailing at the particular location of the plant under consideration. In some localities it is necessary to provide more space between piles to permit drying than is necessary in other localities.

With the bridge type cranes and the hammer-head type crane, storage piles 30 feet high are contemplated. It is not considered advisable to make the storage piles higher than 30 feet, for piles higher than 30 feet are subject to higher insurance rates than are in effect for piles not over 30 feet high. With piles higher than 30 feet the problem of foundations for the piles becomes more serious also.

To save travel of the cranes, for both the bridge type and the hammer-head type, it is contemplated that narrow gauge industrial tracks be laid and that the movement of the material from the storage pile to the retort should be made by the use of these narrow gauge industrial cars, using storage battery electric locomotives, gas driven or compressed air locomotives, or other means suitable to the particular location for tractive power.

The layout of the plant for the use of locomotive cranes contemplates unloading all material arriving in the yard direct to storage piles from the car. All material going from the storage piles to the treating retorts is to be transported to the retort trams on flat cars, loaded and switched by the locomotive crane, the ties being handled in wire rope slings, which remain in position on the loads while in transit from storage pile to retort trams. This method would necessitate many slings, but would save much time in unloading the cars at the retort.

The plan does not contemplate sending the tram cars into the storage yard. Where this is deemed advisable the track arrangement must be altered so as to provide the necessary connections at each end of the retorts.

The height of the piles used in the layout contemplating the use of the locomotive crane varies somewhat with the stock that is being handled, and with the length of the boom of the locomotive crane used. For this particular instance a locomotive crane with a 50-foot boom was considered.

The plans are not complete, as such details as fire protection system, etc., have been omitted. This was intentional, as material handling and transportation is being considered.

Your Committee believes that given any particular plant operation to consider, a thoroughly practical arrangement of mechanical handling can be designed that will be more economical in operation than any system that depends largely upon all stock being handled by manual labor. Each plant must, however, be considered separately and the equipment and methods adopted for that particular operation be determined only after a very careful study of all the factors entering into the operation and life of the plant.

A. H. ONSTAD, *Chairman*
R. L. ALLARDYCE
C. F. FORD
J. C. WILLIAMS

MR. FORD: I move you, Mr. Chairman, that the report be accepted as information.

MR. MATTOS: I second the motion.

THE PRESIDENT: It is moved and seconded that the report of Committee 6–7 on Material Handling be accepted as information. There is much in this report that is worthy of thought, comment and study. It must be said in behalf of this Committee that they have started some new ideas in the minds of all of us relative to proper layouts for the mechanical handling of ties and timbers. Part of the report represents what Mr. Onstad has done in connection with the actual yarding operation at Minneapolis in the Thompson yards, and also shows what the Weyerhaeuser Company has been doing at their lumber yards, so a great deal of this report illustrates is actual machinery in operation. The yard layouts are theoretical as none have been built to date. Are there any other comments in connection with this report. All in favor of the motion as put please say "aye"; opposed, a like sign. It is so ordered.

THE PRESIDENT: Next will be the report of the San Francisco Marine Piling Committee.

MR. MATTOS: Mr. President, the report of the San Francisco Bay Marine Piling Committee is rather long, and I don't want anyone to feel that we are going to take the time to read it. Our object will be to pick out the most salient points and give you an idea of what we have done, and what we are trying to do. Mr. Jurs, who is responsible for a great deal of the work done on this committee, will present the first part of the report, down to the work of the Chemical Division of our Committee.

MR. JURS: Mr. Chairman and Gentlemen: Portions of the report have been abstracted, which I will read. First, I must tell you that last year the report that we submitted was in the shape of a whole piece of fruit, as you might call it, and this year we are nibbling at the core of that fruit. We are trying to find and analyze what the troubles are that cause the enormous loss in San Francisco Bay to marine structures, and to devise means and ways to combat and prevent it.

My one suggestion to any of you engineers handling marine structures would be to get a copy of last year's report and this year's report and see that a copy of each is put in the hands of your wharf construction men, both foremen and superintendents. Not alone see that they get them, but see that they read them. As Mr. Waterman said last night at the Western Society of Engineers' meeting, one of the best things ever done by any corporation or company, is to get the men together at dinner or at your office, and talk to them and try to educate them, because you will get the stuff over only by educational methods. You won't get it over by reading it here; you must get enthused about it, and you have to make everybody else enthused about it to obtain results. [*Applause.*]

REPORT OF THE SAN FRANCISCO BAY MARINE PILING COMMITTEE

INTRODUCTION

The work of the San Francisco Bay Marine Piling Committee herein reported covers approximately the calendar year 1921. The work of the year 1920, which was reported to the American Wood-Preservers' Association at its Seventeenth Annual Meeting in San Francisco on January 26, 1921, clearly demonstrated how large was the field upon which the investigation had entered, and how urgently desirable was the continuation of the work, in order that its largest possible results might be realized. This led to a continuation of the work by the Association. The Committee for the present year, on assuming its duties in accordance with the Association's authorization, carefully considered the problem before it and concluded that adequate results could not be secured by an investigation continuing for less than three years further. It was also decided that in addition to such engineering assistance as should prove necessary, the fundamental nature of the biological and chemical problems warranted the employment of both a biologist and a chemist for full time on the Committee work. On this basis the Committee solicited financial support in the amount of $30,000, or at the rate of $10,000 per year for the three-year period, of which the quota for the year and the major portion of the remainder have been secured. At the end of three years it is anticipated that it will be desirable to reappraise the field and determine what further work if any is necessary.

Division of Work in 1921

Upon the organization of the new Committee it was divided into subcommittees for the better conduct of the several phases of the work, as follows:

Executive
Finance
Service Records
Wharf Construction
Protections
Chemical
Specifications
Biological
Salinities
Supervision of Experiment Station

The field assigned to the several investigative sub-committees will appear in the reports of their work which follow. This subdivision of work is felt to have resulted in much more effective utilization of the interest and energy of the large membership composing the main Committee than could have been accomplished otherwise. In pursuance of its plan of work the Committee has employed, year-long, a biologist and a chemist, with whom contracts have been entered into reserving to the Committee the right of patent, or other disposal, of any new ideas or inventions which may result from their direct employment by the Committee. During the latter part of the year also a competent engineer has been employed full-time on the work of the Service Records Sub-Committee.

Committee Equipment

Through the courtesy of the Southern Pacific Company, the Committee has been able to establish a biological field laboratory and experiment station on that company's freight pier adjacent to the Oakland Mole. Here, with running water both fresh and salt, marine borers have been maintained in continuous health and activity, as well as subjected to varying salinities down to perfectly fresh water. This work is permitting a most valuable controlled check upon the very significant synthesis indicated by the field work this year in respect to the critical factors operative in the survival and extension of *Teredo*. Here also will be tested the toxicity upon marine borers of various creosote constituents and other chemicals. Reached by ladder below the field laboratory is a working platform at the approximate level of high tide, from which experiments under actual tidal conditions can be conducted. This platform and the surrounding piling is also being used by the Subcommittee on Protections for the exposure to borer attack of the various piling protections which it is testing.

Through the similar courtesy of the California & Hawaiian Sugar Refining Company, the Committee is now being supplied with a second biological field laboratory, at Crockett, Calif., just at the critical tension point of *Teredo's* survival in Carquinez Strait during the past season (as discussed in the biological section of this report). At this laboratory, at least during several months of 1922, a second biologist in the employ of the Committee will carry on special investigations under Professor Kofoid's direction with reference to the factors determining this survival. Here also the Committee has installed a recording thermometer for the study of the temperature factor.

In addition to the field laboratories, through the cordial cooperation of the University of California, both the biologist and the chemist of the Committee have the privilege, for Committee work, of the extensive facilities of the University laboratories in their respective sciences.

Four test stations are maintained by the Committee, where test specimens of wood treated with different oils or oil fractions are now under regular observation, in exposure to borer attack. These stations are at State Harbor Commission Pier 7, San Francisco, at the Oakland Mole, the Mare Island Navy Yard, and Crockett. Eight salinity stations are maintained, at Avon, Bulls Head Point, Martinez, Port Costa, Crockett, Black Point, Greenbrae and Tiburon, from which samples of water, in some cases at both high and low tide, are taken and analyzed for salinity.

National Research Council Cooperation

The San Francisco Bay Marine Piling Committee has initiated the project approved by the Executive Committee of the American Wood-Preservers' Association which has resulted in the organization of a special committee on marine piling investigation by the National Research Council, which will thus be able to act as the guiding and correlation center for widely distributed investigative activities in this direction which are contemplated by cooperating agencies at many marine centers of the United States, as well as to form a medium of contact between such activities in the United States and other countries. In furtherance of that project this Committee has enlisted for its specifically scientific activities the service of an Advisory Committee composed of men of the highest scientific rank and attainments, appointed by the President of the University of California from the faculty of that institution; which will provide for this work the authoritative scientific guidance required as a condition of its sponsorship by the National Research Council. This Committee is composed of the following members:

E. C. Lipman, Professor of Soil Chemistry and Bacteriology, Chairman.
C. W. Porter, Associate Professor of Chemistry
C. Derleth, Jr., Dean, College of Civil Engineering.
J. S. Burd, Professor of Agricultural Chemistry.
C. A. Kofoid, Professor of Biology and Assistant Director of the Scripps Institution for Biological Research.
Walter Mulford, Professor of Forestry and head of the Division of Forestry.
D. R. Hoagland, Associate Professor of Agricultural Chemistry, Secretary.

Personnel

The Steering Committee appointed by the Association in pursuance of the motion passed on the floor of the last Annual Meeting, "to study the matter for a short time and perhaps plan what should be undertaken for the year, and make recommendation to the Executive Committee as to the nature, size and personnel of the larger Committee which it might be desirable to appoint later," reported to the Executive Committee of the Association on March 10, 1921. The San Francisco Bay Marine Piling Committee for the present year was appointed, upon its nomination, by the Executive Committee on March 15. The large size of the Committee membership was designed to give representation to all the contributors to and cooperators in the work of the year. The subcommittee organization, which has been noted, has kept it from becoming unwieldy and has utilized its ability to the best effect. The Committee as appointed has suffered some changes by removal and, in one case, by death. These are indicated in the following list:

San Francisco Bay Marine Piling Committee, 1921

F. D. Mattos, Manager Treating Plants, Southern Pacific Company, W. Oakland, California, *Chairman.*

A. A. Brown, Construction Engineer, California & Hawaiian Sugar Refining Company, Crockett, California, *Vice-Chairman.*

W. C. Ball, Sales Manager, Chas. R. McCormick & Company, San Francisco, *Secretary-Treasurer.*

C. L. Hill, in Charge, Office of Forest Products, U. S. Forest Service, San Francisco, *Executive Officer.*

†H. A. Anderson, Engineer, Western Electric Company, New York.

Ernest Bateman, Chemist in Forest Products, Forest Products Laboratory, Madison, Wisconsin.

A. M. Baxter, Vice-President, J. H. Baxter & Company, San Francisco.

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H. J. Brunnier, Consulting Structural Engineer, San Francisco.

*J. S. Burd, Professor Agricultural Chemistry, University of California, Berkeley, California.

C. E. Cortes, Construction Engineer, Shell Company of California, Martinez, California.

*H. O. Demeritt, Assistant Engineer, San Francisco-Oakland Terminal Railways, Oakland, California.

*Chas. Derleth, Jr., Dean, College of Civil Engineering, University of California, Berkeley, California.

*W. W. DeWinton, Engineer, Moore Shipbuilding Company, Oakland, California.

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† Moved to New York during the year.

* Honorary Member.

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*H. F. Faull, Sales Manager, Hammond Lumber Co., San Francisco.
*Emanuel Fritz, Assistant Professor of Forestry, University of California, Berkeley, California.
*H. H. Hall, Chief Engineer, Standard Oil Company, San Francisco.
*G. H. Hicks, Acting Chief Engineer, Northwestern Pacific R. R., San Francisco.
*D. R. Hoagland, Associate Professor of Agricultural Chemistry, University of California, Berkeley, California.
*Lieut. Allen Hoar, Corps of Civil Engineers, U. S. Navy, Bremerton Navy Yard, Bremerton, Washington.†
*Howard C. Holmes, Consulting Engineer, San Francisco, California.‡
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W. M. Jaekle, Assistant Engineer, M. of W. & S., Southern Pacific Company, San Francisco.
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L. D. Jurs, Chief Engineer, Associated Oil Company, San Francisco.
W. H. Kirkbride, Engineer M. of W. & S., Southern Pacific Company, San Francisco.
Dr. C. A. Kofoid, Professor of Zoology and Assistant Director of the Scripps Institution for Biological Research, University of California, Berkeley, California.
*C. A. Kupfer, Consulting Engineer, Berkeley, California.
*C. B. Lipman, Professor of Soil Chemistry and Bacteriology, University of California, Berkeley, Calif., Chairman of Advisory Committee.
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*Walter Mulford, Professor of Forestry, University of California, Berkeley, California.
*Jerome Newman, Consulting Engineer, San Francisco.
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*F. B. Smith, Consulting Engineer, San Francisco.
*O. K. Smith, Assistant Superintendent Mountain Copper Company, Martinez, California.
R. G. Smith, Assistant Manager Fuel Oil & Asphalt Division, Standard Oil Company, San Francisco.

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* Honorary Member.
† Recently transferred from Mare Island.
‡ Deceased October 30, 1921.

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F. G. White, Chief Engineer, Board of State Harbor Commissioners, San Francisco.

J. W. Williams, Chief Engineer, Western Pacific Railroad Company, San Francisco.

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J. S. Burd, *Chairman*
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† Transferred November 26, 1921.

‡ Consulting Member.

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Robert C. Miller, M.A., Biologist
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H. M. Goodman, B.S. in Civil Engineering, Engineer

Contributors to the Fund of the San Francisco Bay Marine Piling Committee, 1921

Associated Oil Company
Atchison, Topeka & Santa Fe Railroad
Balfour, Guthrie & Company
Bethelem Shipbuilding Corporation
Board of State Harbor Commissioners
California & Hawaiian Sugar Refining Company
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Matson Navigation Company
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Moore Shipbuilding Company
Pacific Creosoting Company
San Francisco Bridge Company
Schaw-Batcher Company
Shell Company of California
Southern Pacific Company
Standard Oil Company

SERVICE RECORDS SECTION

In following out the program suggested in last year's report, efforts in the Service Records work during the present year have been directed toward three objectives: (1) to inspect for present condition the now existing structures reported on last year, and thus bring up to date their service record; (2) to uncover more of the great volume of service record material which still lay buried in the files of companies and institutions having waterfront interests in San Francisco Bay; (3) to develop an adequate but practical outline of what a service record should include, for recommendation to the cooperators in the Marine Piling Survey and any others in the San Francisco Bay region who should approve the idea, so that future service records in this region may be both more adequate and more consistent and uniform in the data recorded than they have been in the past.

One of the gratifying results of the work of the San Francisco Bay Marine Piling Committee and its report, as submitted to this Association last year, has been the stimulation of the California Board of State Harbor Commissioners, who control the entire waterfront of the city of San Francisco, to undertake and complete, during the year under present report, a detailed inspection of all the piling on this waterfront, comprising something like 140 acres of piers and wharves. In addition to inspection of existing structures, the files and records of the Board were reviewed for information bearing on the construction and history of the structures which preceded them; all of which information has been summarized in a report prepared for the use of both the Commission and the Committee. This report is accompanied by the tabulated statement of service, completed to date by the inspections of the present year. The report necessarily repeats in some cases information brought out in the report of this Committee last year; but in its entirety the report is so valuable, and it is so difficult to dissect it without doing violence to it, that it is introduced verbatim as a part of the present report. There is no other organization in this region the continuity of whose record is equal to that of the Board of State Harbor Commissioners, their record going back in some cases a little over forty years.

From the Harbor Commission report it can clearly be seen, as was not realized last year from the more limited material then available, that acute engineering, and even public, interest in better protection of piling structures against marine borers in this region, has occurred in nearly regular cycles of close to ten years each. The anxiety in each case was caused by the failure of some scheme or schemes which had been evolved, or to which faith has been pinned, as at last the perfect protection, at the preceding "awakening." And each wave evolved one or more new processes, which were likewise acclaimed in spite of previous experience.

During the years from 1888 to 1890 untreated wooden piling began to be replaced by creosoted piling. This statement does not consider as creosoted piling that treated in San Francisco as early as 1869, by the Robins process of subjecting the wood, in a closed tank, to vapors of creosote. The possibilities of the early creosoted piling at its best were demonstrated by the Oakland Long Wharf piling, reported on at the 1920 convention of this Association, some of which lasted up to 29 years. But that few then realized how the service of potentially excellent creosoted piles could be cut in half, or even more nearly annihilated, by puncturing the creosoted zone with dogs, pikes, axes and bolt holes is not hard to understand when it is still impossible to prevent the piles from being thus abused. The percentage of creosoted piling failures shown by the Harbor Commission report to be due to dogging, it is believed will astonish even many who thought they knew. So a great deal of creosoted piling failed prematurely, and was blamed accordingly, in the decade of the nineties. During that decade, also (or, like creosote, at the last end of the eighties), appeared the first crop of the superficial bituminous coating methods.

The second big wave of anxiety about piling protection appeared in the years from 1898 to 1900, although the introduction of concrete casings placed in steel cylinders had preceded this period by a couple of years. During this time the first form of the Holmes concrete encasing cylinder with a wooden form* was produced. This first form, as it was not made clear in last year's report, was the large cylinder enclosing a cluster of wooden piles. Unfortunately, this less perfect form of the Holmes pile was for a number of years believed by many engineers of this region to be the one final answer to the problem.

In the decade beginning in 1908 attention continued to be focussed strongly on the possibilities of concrete. The more efficient single-pile form of the Holmes cylinder appeared in that year, as did also the Black's Patent method, which was the forerunner of several forms now used for pouring a concrete jacket around a wooden pile in place, section by section, without contact with the water till after it is poured; in the same year also appeared the Koetitz precast concrete cylinder protection for wooden piles, which is shown by the service record to have been so remarkably effective; and at about the same time was introduced the concrete cylinder constructed in place inside a caisson, and the modern precast reinforced concrete pile. In addition to the concrete activity, this decade witnessed renewed and greatly extended use of creosote, as well as a new crop of the superficial coating, or paint and batten, methods.

The period since 1918, which has witnessed the disastrous appearance of *Teredo* activity in San Francisco Bay, has brought renewed development of protective and construction processes, which include representatives of practically every class of process brought forward in previous years. It seems often as if little has been learned, or taken to heart, by such promoters from the experience of the past. But it is a healthful sign that much more effort than formerly seems now being devoted toward securing technically correct workmanship in treatment, construction and inspection, with a realization that only thus can the best methods do themselves justice.

In preparing the statements which accompany the tabulated service records for various classes of piles, which follow the special report of the Board of State Harbor Commissioners, presented herewith, it has been the endeavor not to repeat the information developed at length in last year's report, except as becomes necessary for purposes of intelligent comparison. In view, however, of the fact that this committee, by authority of your last year's meeting, has now embarked upon a continuing program, it is felt that the service record tabulations themselves should be cumulative, presenting from year to year the total body of record which has been obtained for this region. The tabulations herewith presented, accordingly incorporate last year's data with that obtained this year. They also repeat the tabulated data presented in the special report of the Harbor Commission, so as to make it conveniently available with respect to each separate class of piles. A final summary, similar to that of last year, has also been stated, so as to keep up to date any modifications of conclusions which may from time to time become necessary.

SERVICE RECORDS FROM STRUCTURES OF THE BOARD OF STATE HARBOR COMMISSIONERS AT SAN FRANCISCO

The files of the Board of State Harbor Commissioners constitute a forty year service record comprising almost all types of commercial pile construction, which have been introduced in San Francisco Bay during this period.

The efforts of the early Boards were largely directed toward repiling existing structures and contain frequent references to the enormous expense of these replacements. In this work piles with the bark intact and unbroken appear to have been the standard type used, although some methods of preservation such as "built up" piles and coatings were attempted. In 1888, in the report of the Board to Governor Waterman, the first reference is made toward the adoption of a policy of preservation as follows:

> "The Board has given much attention to the various methods for the preserving of piles and timber from the ravages of *Teredo** and *Limnoria*. The engineer of the Board is emphatic in his opinion that thorough creosoting is the best remedy that has so far been used for this purpose and reports that this has been demonstrated both in Europe and in this country."

The biennial reports for 1891–2 contain the contracts for treated piles. These were let to the Pacific Improvement Company for 14-pound and 15-pound treatment with creosote and to the Paraffine Paint Company for coating piles. From this time the biennial reports list contracts for both coated and creosoted piles.

In 1898 the biennial report of Governor Budd contains the following reference to methods of preservation:

> "The preservation of piles and timber is the one overshadowing question in the administration of waterfront affairs. In the course of a trial recently, in the Superior Court of San Francisco, involving a consideration of the merits of the various methods of preserving piles, the fact was brought out upon the testimony of three of the foremost civil engineers on this Coast that the methods of pile treatment adopted by this Board will preserve the piles for from twenty to twenty-five years."

The methods of treatment referred to were apparently "coating" and "creosoting," described as follows in the report:

> "These patents embrace different forms of artificial covering for piles, while others call for the injection of antiseptics and other chemical matter into the pile itself, which is accomplished after a degree of porousness is formed in the wood by extraction of the sap and moisture therefrom."

Notwithstanding the testimony of the "three foremost civil engineers," all of the treated and coated piles of this period failed long before the twenty to twenty-five year period expired. The report of the Chief Engineer in the same biennial report (1898) contains the following significant paragraph which may account for the unfavorable behavior of the preservatives:

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* Where *Teredo* is spoken of as present on the Pacific Coast in engineering publications of former years, *Xylotrya* is undoubtedly to be understood. There is no biological evidence of the presence of *Teredo* in San Francisco Bay until the invasion of recent years.

> "All authorities in writing on the preservation of piles for marine work seem to ignore the existence of the *Limnoria.* In my opinion, it is much more destructive on this coast than the *Teredo,* and while a pile that has been thoroughly creosoted will resist the *Teredo even if somewhat checked, the Limnoria will find the slightest opening and destroy the pile.*

That these protections while not lasting the anticipated period were nevertheless beneficial is attested by the Chief Engineer in the Biennial Report of 1900, as follows:

> "With few exceptions, the piling of old structures has been done with coated or creosoted piles, and although the same have not proved to be of such irresistible nature against the attacks of the *Teredo* and *Limnoria* as at first anticipated, nevertheless the life of these piles will be greatly prolonged and the present enormous expense for repiling somewhat reduced in the future."

In the period from 1895 to 1900 the Board in addition to utilizing coated and creosoted piles made a beginning in creosote substructures. The foundations for the Ferry Building were completed September 1, 1895. In this construction clusters of green piles aggregating 5200 were encased in rectangular concrete piers which were constructed inside of an open coffer dam. Following this construction the substructure for Pier 5 and for Folsom Street Wharf were constructed in 1896 of green pile clusters which were encased with concrete placed inside of a cylindrical shell of 3/16-inch boiler plate. These types of construction have proven satisfactory and the substructure supports are still in use.

About 1900 there was developed the concrete cylinder substructure known as the Holmes patent. In its earlier form this consisted in the surrounding of clusters of green piles with a wooden stave cylindrical form driven into the mud and sealed at the bottom after which concrete was poured for encasing the piles.

From 1901 to 1907, Piers 7, 11, 19, 21, 23, 25 and 27 were built of this type of construction. In the Biennial Report of 1908 the Assistant State Engineer reports as follows:

> "There are practically two kinds of piers in existence on the waterfront of San Francisco. One is the pier resting on creosoted piles and comprises the remains of the old work, completed previous to the use of the Howard Holmes patent. The other comprises the piers resting on piles protected by concrete according to Mr. Holmes' patent . . .
>
> "Those of the first kind are very hard to maintain, and it has been the policy of the Board for a long time to construct all new piers on the patented piles . . ."

But speaking of the patented piles he later adds:

> "In a few instances the concrete cylinder piers have failed and fallen from their position. This latter failure is undoubtedly due to the *practice of placing the concrete for a considerable portion of the bottom of the cylinders under water* without any special device to prevent a separation of the ingredients."

Since 1908 when the above was written the cylinder piers of this type have likewise proven "very hard to maintain" and have been generally repaired by replacement of faulty cylinders. These replacements were due in part to the disintegration of poor concrete (probably poured into the sea water) but principally to failure to properly seal the cylinders and encase the piles at the mud line. Numerous cylinders were replaced with creosoted piles from 1913 to 1915 and additional repairs were made in 1921, when all of these structures were examined by a diver. The number of cylinders remaining in serviceable condition is recorded in the tabulated service records.

In 1908 an improved type of concrete cylinder was developed in which the creosote was deposited inside of a steel coffer dam which was driven into the bottom and pumped dry. After concreting, the steel shell was pulled and re-used on succeeding cylinders. In this manner the disadvantages of pouring concrete through water were minimized. Piers 36, 38, 40, 39, 26, 28, 30 and 32 were constructed under this system from 1909 to 1914. These piers are giving good service except for construction defects due to careless workmanship. The principal defects have resulted from the use of excessively wet mixes from insufficient tamping and failure to properly clean construction joints. Piers 26 and 28 were particularly faulty in respect to construction joints at low water. The upper portions of these cylinders were poured on top of an accumulation of laitance and silt which was subsequently washed out and was replaced by grouting. Certain cylinders show signs of disintegration due to excessively wet mixes and lack of tamping. These cylinders have been repaired by encasing them in a 3-inch shell of dense concrete deposited similarly to the "Black Patent" process for concreting piles. The number of repaired cylinders and general condition of the structures are recorded in the tabulated service records.

A modified type of Holmes cylinder was also developed about 1908 and was incorporated in Pier 34 constructed in 1910. In this type a single pile was encased in concrete with special gaskets for sealing the bottom and facilitating the pumping out of the casings. A diver's examination has been made on alternate bents of Pier 34, the results of which are tabulated in the appended service records. No repairs have been made on this pier, which is in good condition after 11 years exposure.

The Koetitz type of concrete protected pile was also developed about 1908. In this type the green pile was encased in a precast concrete shell, the space between the shell and the pile being filled with sand or grout. Between 1908 and 1910 approximately 2500 lineal feet of concrete bulkhead wharf was constructed on this type of protected pile and in 1911 Pier 17 was constructed entirely on this type. These structures have given good service and are in first class condition. The piles in the bulkhead wharves have developed inconsequential defects in small cracks over the reinforcing of the cylinders. Cracks of this nature are of less import than in the case of reinforced concrete piles as the casing is largely a protection for the green pile and cracking occurs only above the water line. Neither the structural efficiency of the encased pile nor the protective value of the casing is greatly affected.

Still another type of concrete protected pile developed in 1908 is the "Black Patent" type in which concrete is placed in sectional forms above the water level which are lowered on the pile as the filling of the form proceeds. Two small contracts for this protection were let in 1908–9; the remaining piles of which have been inspected and recorded in the tabulated service records. In general these piles appear to be sound to the mud line and those which have failed have been eaten off at the mud line because the protection was not carried below that point.

During the period from 1900 to 1910, while experimenting with the various concrete supports outlined above, the Board also continued to utilize considerable quantities of green piles, coated piles and creosoted piles. In 1908, 1200 eucalyptus piles, all of which were eucalyptus globulus according to the report of the engineer, were purchased and driven largely in the Ferry Slips. These piles were a disappointment for this purpose, failing partly by breakage and partly by the attacks of *Xylotrya*. They were all replaced in 1912. Four of these piles, however, installed as mooring and fender piles in Pier 38 have been in place to date. These piles have been cut off by *Xylotrya*, at the mud line, but show very little of the characteristic *Limnoria* attack at low water line.

All of the coated piles driven during this period have been replaced or removed, a typical example being Pier 9. This pier originally of green piles was rebuilt with coated piles in 1903. The coated piles were replaced with creosoted piles in the period from 1911 to 1915.

Most of the creosoted pile construction of this period (1900–1910) has likewise been removed or replaced. This construction included the timber bulkhead wharves along the seawall which have been recently reconstructed as concrete bulkhead wharves. Replacement was necessitated both by deterioriation of the creosoted piles and the decay of the timber decks. There are a number of creosoted piles installed during this period now in use in the ferry slips but they are so intermixed with newer construction that a survey and report is unreliable. The earliest creosoted pile structure which has been maintained intact is the freight slip extension to Pier 36 constructed in 1909. These piles are in fairly good condition as noted in the appended tabulation. Next in length of service are the creosoted piles used in repiling of Piers 7 and 9 and in the track extensions of Piers 20 and 21 installed about 1912.

During the years 1914–16 a very extensive creosoted pile program was carred out by the Board. This program included the repiling of Piers 11, 19, 21, 23, 25, and 27 and the construction of Piers 14, 15, 16, 18, 20, 22, 37, 41, and 46. During the past year most of this construction has been carefully inspected and considerable repairing has been carried out in the way of plugging the holes between tides, which have been subjected to *Limnoria* attack. This is done with cement mortar which is forced into the holes and then pointed with plaster of paris to protect the cement mortar from the tide. A record of all piers repaired is given in the tabluated service tests. In general it may be stated that 80 per cent of the abrasions attacked are produced by pile dogs; about 15 per cent by checks developed during or since driving and the balance from miscellaneous defects. In some of the repaired piers (19,. 21, 25, and 27) steel staging bolts were used which were withdrawn without plugging the holes. These openings were heavily attacked. In all cases the piles of the repaired piers on the north side of the Ferry Building contained larger holes and were more heavily attacked than the piles in the new piers to the south. This is possibly due to the increased abrasion of the piles where driven through the roof and deck of existing work as compared with the unobstructed work on new piers. It was impossible to patch the inaccessible portion of the piles below the water line, but judging from the extent of the attack which is visible it is thought that the stability of the piles will not be appreciably reduced for at least another six year period, at which time a percentage of the piles must be repaired or replaced. *Xylotrya* or *Teredo* attack was visible only where piles had been split or checked; in these cases it was more rapid and serious than the *Limnoria* attack in small abrasions.

In 1911 pre-cast reinforced concrete piles were introduced in the Bulkhead Wharf of Pier 17. This construction has been adopted for all succeeding bulkhead wharf construction aggregating approximately 8500 feet of bulkhead. Following the destruction of Pier 46 by fire in 1916, the creosoted pile construction was considerably curtailed, and pre-cast concrete pile construction somewhat extended. Pier 35 was constructed in 1915 and Piers 3, 29, 31, and 33 in the period from 1916 to 1918. In these piers concrete piles up to 100 feet in length have been satisfactorily handled and driven. This construction together with the concrete cylinder construction has been periodically surveyed for defects and deterioration. The later concrete pile structures show no deterioration as yet, but the earlier bulkhead wharves are beginning to show cracks due to the rusting of the reinforcing above the water line. No deterioration has been discovered below the water line.

Summary

The following types of substructure support have given satisfactory service and may be considered reliable when properly designed and constructed:

1—Concrete piers and cylinders laid in open coffer dams;
2—Steel cylinder shells filled with concrete;
3—Single green piles encased in concrete;
4—Creosoted piles;
5—Pre-cast concrete piles.

The efforts of the Engineering Department in all new construction are largely directed toward more exacting work than is necessary in inland construction. In the case of concrete the principal desideratum is density and imperviousness which is obtained by proper proportioning, by the exclusion of sea water or surplus mixing water and by excess tamping. In the case of creosoted and protected piles the principal desideratum is the preservation intact of the protective shell or coating in order to prevent ingress of the borers to untreated timber. The success or failure of each of the above types is directly proportional to the degree of perfection with which these two requirements are fulfilled.

TABULATION OF SERVICE RECORDS OF EXISTING STRUCTURES ON THE WATERFRONT OF SAN FRANCISCO

STRUCTURE	DATE CONSTRUCTED	NUMBER OF SUPPORTS	CONDITION 1921 INSPECTED BY DIVER
GREEN PILES ENCASED IN RECTANGULAR CONCRETE PIERS PLACED IN OPEN COFFER DAMS AND CARRIED 2 TO 3 FEET BELOW MUD LINE			
Ferry Building Foundation	1895	5,200 Green Piles	Concrete and piles in first class condition with exception of 5 piers opposite ferry slips where mud has been partially removed by scouring action of propellers. Five piles exposed to *Xylotrya* attack.
GREEN PILES ENCASED IN CONCRETE DEPOSITED INSIDE OF STEEL SHELLS COMPOSED OF 3-16 INCH BOILER PLATE.			
Pier 5	1896	130	All cylinders intact,—utilized in construction of floor 1919 and 1920.
Pier 20	1896	120	All cylinders intact and in service Some cylinders are hollow at mud line according to diver's report.
Boiler Foundations, Ferry Bldg. and supports for upper deck apron, north side Slip 4	1896-1900	17	Inspected by diver. One cylinder has hole near mud line. Cylinders utilized in reconstructing concrete floor, in 1921.
HOLMES CYLINDER SUPPORTS CONSISTING OF GREEN PILE CLUSTERS SURROUNDED BY 3-FOOT TO 4-FOOT CONCRETE CYLINDERS			
Pier 19	1903	234	181 Cyl. removed—53 Cyl. remain in good condition.
" 21	1903	234	206 Cyl. removed—28 Cyl. remain in good condition.
" 23	1908	234	168 Cyl. removed—66 Cyl. remain in good condition.
" 25	1903	273	172 Cyl. removed—101 Cyl remain in good condition.
" 11	1905	490	440 Cyl. removed—50 Cyl. remain in good condition.
" 7	1903	486	353 Cyl. removed—153 Cyl. remain in good condition.
HOLMES PILE CONSISTING OF SINGLE GREEN PILE ENCASED IN CONCRETE			
Pier 34	1909	770	All piles intact and giving satisfactory service. Inspected on alternate bents by diver with following results: 2.08 per cent have pile exposed. 13.50 per cent have minor defects such as grooves 1 inch deep. 84.42 per cent perfect.
CONCRETE CYLINDERS CONSTRUCTED INSIDE OF A STEEL COFFER DAM SHELL			
Pier 36	1909	427	All cylinders intact, minor repairs necessary in some cases. Ten cylinders repaired by encasing in a 3 inch shell of dense concrete.
Pier 38	1909	437	All cylinders intact, minor repairs necessary in some cases. 47 cylinders repaired by encasing in a 3 inch shell of dense concrete.

SERVICE RECORDS OF EXISTING STRUCTURES ON WATER-FRONT OF SAN FRANCISCO—Continued

STRUCTURE	DATE CONSTRUCTED	NUMBER OF SUPPORTS	CONDITION 1921
CONCRETE CYLINDERS CONSTRUCTED INSIDE STEEL COFFER DAM SHELL—Cont.			
Pier 40	1909	440	All cylinders intact, minor repairs necessary in some cases. 51 cylinders repaired by encasing in a 3 inch shell of dense concrete.
Pier 28	1912-13	451	All cylinders intact. 142 cylinders in depressed track and outside row defective at low water joint; all repaired by grouting or concreting joint. 76 cylinders repaired by encasing in a 3 inch shell of dense concrete.
Pier 26	1912-13	664	All cylinders intact. 161 cylinders in depressed track and outside row defective at low water joint; all repaired by grouting or concreting joint. 27 cylinders repaired by encasing in a 3 inch shell of dense concrete.
Pier 39	1913	531	Condition good. No repairs to date but small amount of patching necessary.
Piers 30-32	1913	1,509	Conditions good. Cylinders have rough surface but concrete is sound and shows no disintegration.
CONCRETE-PROTECTED GREEN PILES—KOETITZ METHOD			
Pier 17	1911	1,130	All supports in first class condition.
Bulkhead 28 to 30	1909	29	17 piles show small rust cracks above high water. Otherwise, piles in first class condition.
Bulkhead 26 to 28	1909	33	18 piles show small rust cracks above high water. Otherwise, piles are in first class condition.
CONCRETE-PROTECTED GREEN PILES—"BLACK PATENT" METHOD			
Fisherman's Wharves	1908-1909	250	211 have been removed because of failure at mud line. 39 in serviceable condition and now in use.
Pier 7 Repairs	1909	Est. no. in contract—50; 34 now in place	27 in serviceable condition. 7 gone at mud line.
CREOSOTED PILE CONSTRUCTION			
Pier 36 Outer End	1909	570	Piles in fair condition. 113 piles repaired between tides by cementing *Limnoria* poles. 17 piles require replacement as shown by inspection between tides.
Pier 9 Repiling	1911-1915	1,680	Piles in poor condition. Inspected by diver as follows: 518 piles in good condition; 1,010 have *Limnoria* holes between tides; 152 piles require replacement.
Pier 7 Repiling and Track	1912	936	Diver's examination: 786 piles in good condition; 102 defective above low water; 21 defective at mud line; 27 defective at cut off.

SERVICE RECORDS OF EXISTING STRUCTURES ON WATERFRONT OF SAN FRANCISCO—Concluded

STRUCTURE	CONSTRUCTED DATE	NUMBER OF SUPPORTS	CONDITION 1921
CREOSOTED PILE CONSTRUCTION—Continued.			
Pier 20	1912 Depressed Track	84	19 piles replaced because of *Xylotrya* attack.
Pier 19 Reconstruction	1914	528	Heavy *Limnoria* attack in dog holes, staging holes and checks. 329 *Limnoria* holes sealed with cement.
Pier 23 Reconstruction	1914	511	Heavy *Limnoria* attack in dog holes, staging holes and checks. 292 *Limnoria* holes between tides sealed with cement.
Pier 25 Reconstruction	1914	714	Principal *Limnoria* attack in staging holes. 455 *Limnoria* holes between tides sealed with cement. 16 piles replaced.
Pier 27 Track Extension and Reconstruction	1914	573	Considerable *Limnoria* attack in dog holes. 200 *Limnoria* holes between tides sealed with cement. 12 piles replaced.
Pier 14	1914	1,557	Light *Limnoria* attack in dog holes and checks. 481 *Limnoria* holes between tides sealed with cement.
Pier 15	1914	1,379	Light *Limnoria* attack in dog holes and checks. 394 *Limnoria* holes sealed with cement.
Pier 16	1914-15	1,381	Light *Limnoria* attack in dog holes and checks. 289 *Limnoria* holes sealed with cement.
Pier 18	1914-15	1,381	Light *Limnoria* attack in dog holes and checks. 190 *Limnoria* holes sealed with cement.
Pier 21 Reconstruction	1915	560	Heavy *Limnoria* attack in dog holes and checks. 442 *Limnoria* holes between tides sealed with cement.
Pier 11 Reconstruction	1915	1,092	Considerable *Limnoria* attack in dog holes. 340 *Limnoria* holes between tides sealed with cement.
Pier 22	1915	658	Light *Limnoria* attack in dog holes and checks. 136 *Limnoria* holes sealed with cement.
Pier 24	1915	1,452	Light *Limnoria* attack in dog holes and checks. 386 *Limnoria* holes sealed with cement.
PRE-CAST CONCRETE PILE CONSTRUCTION			
Pier 17 Bulkhead Wharf	1911	135	41 piles show rusting cracks over the steel above the high water line. Otherwise, in first class condition.
Section 11-A Seawall	1912	141	36 piles show rusting cracks above high water. Otherwise, all piles in good condition.
Pier 35	1915	2,492	56 piles badly cracked above high water. 215 piles slightly cracked above high water. Otherwise, piles in good condition.

Untreated Piles

(See table 1)

Definite service records have this year been tabulated for a large number of untreated wooden pile structures not listed last year. The striking fact brought out is that every pile reported last year has been torn out or replaced, and that practically all those now listed have been likewise disposed of, except those, as in some cases, which were revamped by the concrete jacket method.

That the results to be obtained with untreated piles are directly governed by their exposure has been very forcefully demonstrated in the experience of the San Francisco-Oakland Terminal Railways. Their original trestle was constructed in 1902 on untreated piles and for a period of five years was equal to all demands. From this time forward the severity of attack was increasingly pronounced. In the year 1913 some 30 untreated anchor piles were destroyed in a single season. This would seem to indicate that an untreated pile structure in a location isolated from structures known to be harboring marine pests can be expected to last considerably longer than an untreated pile structure in close proximity to structures known to be infested. This is true in spite of the fact that the marine pests are present at all times. Untreated piles are also more severely attacked at the outer end of piers, or in deep water, than they are in shore or in shallower water.

This condition is very often altered by unusual local influences. The experience of the Howard Company of Oakland illustrates the point. Their original pier was built upon untreated piles in 1900 and required little or no attention for about 8 years. They were so pleased with the results obtained with this type of cheap construction that replacements were made with untreated piles. During these years the effluent from a gas plant at the foot of Market St., Oakland, was being discharged into the Estuary and the useless by-products from the manufacture of illuminating gas were deposited by tidal currents as a surface coating on the untreated piles of the Howard wharves which are adjacent. This practice was ordered stopped by the Fish and Game Commission, together with the Oakland Port authorities. The life of these untreated repair piles, thereafter, was limited to what might have been expected in waters where *Limnoria* are active. The Howard Company are now using only creosoted piles under their wharf structures. In the fender systems untreated piles are still being used.

The findings of this Committee during the last year, pertaining to bark as a protection to untreated piles do not materially

TABLE 1. UNTREATED PILE STRUCTURES

Service Record up to December, 1921

Owners	Structure and location	Year completed	No. of bearing piles	No. of piles replaced.	No. of piles repaired	Remarks
California Wharf and Warehouse.........	Wharf Port Costa..	Not stated	3714	638	2259	Piles repaired with concrete moving form method. Piles replaced composite, i. e., creosote and untreated.
Granger Bus. Ass'n..	Wharf Eckley	Not stated	2540	2540	None	Replaced with Paraffine paint piles.
S. F. Oak. T. Ry.....	Trestle.......	1902-3	5000	5000	None	Replaced with paint protected piles in 6 years time.
	Terminal Yard.......	1902-3	500	500	None	Replaced with paint protected piles in 4 years.
	Side Wharves	1902-3	2000	2000	None	Repiled with paint protected piles in 5 years.
	Extensions ..	1904-5	1000	1000	None	Repiled with paint protected piles in 4 to 5 years.
	Extensions ..	1905	330	330	None	Replaced in 4 years with paint protected piles.
	Extensions ..	1906	400	400	None	Replaced in 8 years with paint protected piles.
	Line Poles...	1913	80	80	None	Replaced with paint protected piles 10 months life.
S. P. Co...............	Slip—Alameda..........	1921	16	None	None	Eucalyptus dolphins
	Auto Slip—Oak. Mole..	1921	16	None	None	Eucalyptus dolphins.

TABLE 1. UNTREATED PILE STRUCTURES—Concluded
Service Record up to December, 1921

Owners	Structure and location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
Associated oil........	Port Costa...	1910	387	387	None	166 replaced with creosoted piles 1920.
	Wharf Head Avon.......	1913	551	6	None	Pulled for examination only. Were replaced with creosoted piles.
	Approach Avon.......	1913	1126	1	None	
Hanlon Shipbuilding	Oakland Estuary.......	1917	Not stated	Total	None	Piles replaced in two years.
	Oakland Estuary.......	1919	Not stated	Total	None	*Limnoria* galleries burned out with torch and painted with Argentine Quebracho.
U. S. Lighthouse Ser.	Carquinez Light.......	1908	94	None	94	Attacked 1917. Endangered 1920. Repaired with concrete, moving form method.
U. S. Navy............	Mare Island Causeway..	1918-19	1933	804	925	Replacements: creosoted, 702; paint, 13; untreated, 89. Not replaced, 204. Repaired with concrete sleeve.
	Ammunition Pier No. 1..	....	597	461	133	Replacements: Paint, 66; creosoted, 395. Repaired with concrete sleeve.
	Ammunition Pier No. 3....	....	261	261	....	Replaced with creosoted piles.
Howard Co...........	Oakland Estuary.......	1900	Not stated	Large %	None	Piles protected by effluent from gas plant 8 years.
	Same rebuilt	1908	Not stated	Large %	None	Piles protected by effluent from gas plant 6 years.
	Same rebuilt.	1914	Not stated	Total	None	Replaced 1917 with creosoted piles.

alter the conclusions appearing in the last report (plate 1, fig. 1).

We now have service records for eucalyptus piles that are worthy of study. From the report of the Board of State Harbor Commissioners which has been given, it will be noted that the large number of eucalyptus globulus piles driven in 1909 failed. partly by breakage and partly from *Xylotrya* attack, within four years. In Pier No. 38 four of these piles (mooring and fender) are still in place, although gone at mud line from *Xylotrya* action. The San Francisco-Oakland Terminal Railways used a large number of eucalyptus piles in their original trestle. In the stub of original trestle still remaining in place there are standing some few, number indeterminate, whose life has approximated ten years. Conditions at the S. F.-O. T. Ry. pier are much less favorable to *Teredo* and *Xylotrya* than on the San Francisco side, but *Limnoria* is apparently much less affected.

Eucalyptus globulus piles seem from the present evidence to resist the attack of *Limnoria* to a greater extent than does Douglas fir, but of *Teredo* and *Xylotrya* little if any better. Any advantage which this species might have in respect to borer resistance is in most cases, however, negatived by mechanical failure, due to its excessive tendency to split and check either in driving, or under the effects of weathering or the impact of boats in subsequent service.

Untreated piles, unprotected, still have their use in temporary marine structures, but extreme care must be used in investigating local conditions. The principal things to note are: (1) exposure to attack (see tables of salinity for locality; note proximity of infested structures), (2) possibility of protection by local contamination which may in some cases prove an unfavorable environment for pests. No sufficient knowledge is yet available as to the nature of such contaminations. The purpose for which a structure is to be used will determine whether it will have outlived its usefulness prior to the time of anticipated collapse.

Untreated piles in uncontaminated salt water, known to be infested, will withstand the attacks of *Limnoria*, without losing their structural usefulness for periods up to three years; in water containing sewage or other contaminations where borers are known to be present untreated piling appears in some cases to last longer than that. *Limnoria*, however, does not seem to be affected by sewage contamination as much as *Teredo* and *Xylotrya*. Untreated piles in uncontaminated salt water have been destroyed in as short a time as six months by *Teredo* and *Xylotrya*. Untreated piles in salt water have had longer than the average life in locations removed from other infestation or where local conditions were unfavorable for marine borers.

Metal Protective Coatings

This type of protection is no longer in as common use as it is known to have been in former years. No new information has come to light during the period covered in this report to alter the conclusions stated in the 1921 Report. These conclusions are summarized at the end of the present report.

Paint and Batten Protective Coatings

(See table 2)

The usefulness of this method of protecting untreated piles has been shown in last year's studies and report. The report of the Chief Engineer of the Northwestern Pacific Railroad Company covering an installation at Petaluma Creek indicates some of the primary considerations that determined their selection of this type of pile. These, briefly stated, were: (1) lower initial cost as compared with creosoted piles; (2) possibility of salinity being so reduced by a return of wet years, and increased fresh water flow, as to kill off marine pests; (3) possibility of structure becoming obsolete before the expected life of pile would be reached; (4) sheltered location.

The difficulty in determining the life of piles protected by surface coatings in this harbor, as noted in last year's report is that most of the installations have been removed without adequate record having been kept. The several extensive installations of such piles made during the years 1920 and 1921, as shown in the accompanying tabulation, it is hoped can be kept under continuous observation and record.

With protected piles the importance of position of mud line cannot be overlooked, as called to attention in last year's report. In the use of this type of pile the mud line cannot be lowered or the protection loses its effectiveness. A study into the causes that could bring about a change of bottom conditions must be made before deciding in favor of this type of bearing pile. The desirability should also be borne in mind of using such construction in waters sheltered from excessive storm action, on account of its susceptibility to abrasion.

The service records covering paint and batten protective coatings were pretty thoroughly canvassed and evaluated in the 1921 report. We have nothing new that would change the conclusions appearing therein, which are summarized at the end of this report. Piles treated with the better types of coating will always find a place in semi-temporary marine construction. It should,

TABLE 2. PAINT AND BATTEN PROTECTIVE COATINGS
Service Record up to December, 1921

Owners	Structure and location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
S. F. Oak. Ter. Railways	Train shed	1906-07	500	500	None	Paraffine paint piles replaced in 2 to 3 yrs. with concrete cylinders.
	Side wharves	1907	1000	1000	None	Paraffine paint piles replaced in 7 to 8 yrs. with creosoted piles.
	Terminal	1909	2000	2000	None	Paraffine paint piles replaced in 5 to 6 yrs. with creosoted piles.
	Dolphins	1909	100	100	None	Paraffine paint piles replaced in 5 yrs. with Columbia paint piles.
	Anchor piles	1913	30	30	None	Columbia paint piles replaced in 7 yrs. with creosoted piles.
	Dolphins	1914	120	None	None	In service today—Columbia paint.
Northwestern Pac. Railway	Trestle, Petaluma Cr.	1920	252	None	None New work	Paraffine paint piles.
Grangers Bus. Association	Wharf, Eckley Sta.	1920-1	2294	None	New work	Paraffine paint piles.
S. P. Co.	Georgia St. wharf, Vallejo	1921	18	None	None	Moran piles—Dolphins.
	Georgia St. wharf, Vallejo	1921	18	None	None	Paraffine piles—Dolphins.
U. S. Navy	Causeway	1921	13	None	New work	Quebracho painted replaced untreated.
	Dike 12	1920-21	301	None	New work	" " " "
	Ammunition Pier 1	1921	66	None	New work	" " " "

however, be added that, since the cost of paint and batten coatings is greater per linear foot applied than is that of creosote treatment, the lower cost per pile of the former method, which is usually assumed as compared with the creosote treatment, is influenced by the relative length of water section of the pile. The advantage of the coated piles in cost decreases as the length of the water section increases, especially when the increased water depth is accompanied by decreased bottom driving depth.

Concrete Protections

(See table 3)

The report of 1921 described in considerable detail the numerous types of concrete protection which have been utilized on San Francisco Bay. These types are characterized by various ingenuities in applying the protection, but they may be roughly classified in two general groups,—pre-cast protections and cast-in-place protections.

The principal representative of the pre-cast group hitherto used on San Francisco Bay is the Koetitz pile in which type the untreated pile is surrounded with a concrete shell, cast separately and set in place after the pile has been driven. (plate 1, fig. 2, and plate 2, fig. 1.)

The cast-in-place group includes the various simple methods of concreting piles between the tides, the encasing of piles with steel shells or pipes filled with concrete, the Holmes patent for depositing concrete in a wooden casing driven into the bottom, and the various modifications for lowering the plastic concrete casing down the pile as the depositing of plastic concrete proceeds. (Plate 2, fig. 2, and plate 3, fig. 1.)

During the year a new process has appeared which is sufficiently unique to require separate classification and may become the prototype for a third group—the Newsom Squire pile which is cast simultaneously with the driving of the pile and which utilizes the impact of the pile hammer both for securing penetration in the bottom and for compacting the plastic concrete.

The service records which have become available confirm last year's favorable report on the excellence of pre-cast protections of the Koetitz type. Piles of this type have been exposed for twelve years in bulkhead wharves and for ten years in Pier 17 of the San Francisco Waterfront without a single repair or replacement and with no visible deterioration other than a few small cracks above the high water line.

With reference to cast-in-place protections, attention is directed to the long service obtained from the steel shell cylinders of Piers 5 and 20 which have been in place for approximately twenty-five

TABLE 3. CONCRETE PROTECTIONS
Service Record up to December, 1921

Owners	Structure and Location	Year com-pleted	No. of bearing piles	No. of, piles replaced	No. of piles repaired	Remarks
Board of State Harbor Comm'rs.......	Pier 34.......	1910	770	None	None	Holmes single pile—survey shows 16 with pile exposed. 104 with minor defects.
	Pier 17.......	1911	1130	None	None	Koetitz cylinder—First class condition.
	Bulkhead 28-30...........	1909	29	None	None	Koetitz cylinder—survey shows 17 piles have small rust cracks above H. W.
	Bulkhead 26-28...........	1909	33	None	None	Koetitz cylinder—survey shows 18 piles have small rust cracks above H. W.
	Pier 5........	1896	130	None	None	Placed in 3/16" boiler plate form all in service.
	" 20........	1896	120	None	None	Placed in " " " " "
	" 7........	1903	486	353	None	Holmes clusters—strengthened 1912 with creosoted piles.
	" 19........	1903	234	181	None	" " " 1914 " " "
	" 21........	1903	234	206	None	" " " 1915 " " "
	" 23........	1903	234	168	None	" " " 1914 " " "
	" 25........	1903	273	172	None	" " " 1914 " " "
	" 11........	1905	490	440	None	" " " 1915 " " "

TABLE 3. CONCRETE PROTECTIONS—Concluded

Service Record up to December, 1921

Owners	Structure and Location	Year com-pleted	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
S. F.—Oak. T. Railway	Terminal Tracks 1, 2, and 3.......	1906-7	273	278	None	Holmes clusters, replaced 1912-3 with creosoted piles.
	Oil tank......	1905	10	10	None	Holmes clusters, replaced 1912-13 with 2 creosoted piles.
	Train shed...	1909	132	182	None	" " " 1914 with creosoted piles.
Board of State Harbor Comm'rs	Fisherman Wharf......	1908-9	250	211	None	Black's patent—Failed at mud line.
	Pier 7 repairs	1909	50 (est)	16	None	" " " " "
California Wharf & Warehouse Co......	Port Costa...	1921	2259	....	New work	Larsen-Camp process—100 required patching during construction. 92 repaired following diver's inspection before acceptance.
U. S. Lighthouse......	Carquinez....	1921	94	....	New work	Larsen-Camp process—Satisfactory job.
City of Berkeley.....	Wharf........	1908	245	7	140	Holmes single pile casing—Repaired 1920.
U. S. Navy............	way....	1921	925	None	New work	Stationary form type cast in place.
	Ammunition Pier........	1921	183	None	New work	" " " " " "

years. An examination by diver has verified last year's statement that the Holmes piles of Pier 34, in contrast to the Holmes cylinders in other piers, are in good condition and confirms the conclusion that satisfactory results with this method depend largely on intelligence and skill of execution which is difficult to obtain under working conditions. Records of Black Patent pile repairs on the San Francisco waterfront indicate failures through neglect in penetrating the bottom at the mud line. In the recent modification of this process, known as the Larsen patent, as installed by Mr. Frank Camp at the California Wharf and Warehouse, Port Costa, an attempt has been made to remedy this defect by jetting the lower section into the mud bottom. In this particular structure 2259 piles were repaired and reinforced during the past year, and while deductions with regard to durability are premature, mention should be made that their extensive repairs were executed without the interruption of a heavy grain warehouse business. (plate 3, fig. 2, and plate 4, fig. 1.)

In general it may be stated that uniformly dense and impervious coatings of concrete extending from well below the mud line to above the water line and reinforced sufficiently to resist blows and internal stress offer a highly satisfactory method of protecting untreated piles. The service tests bear out theoretical contentions that coatings of the high quality required are readily obtained in pre-cast work, and that under favorable conditions they may be obtained by skill and intelligence in cast-in-place methods.

On the other hand cast-in-place protections offer the only commercial method of repairing defective piles and supports in place. Their value for this purpose when applied between high and low tide is attested by the numerous installations in all parts of the Bay. The durability of these repair coatings below low water depends on the effectiveness with which water is excluded from the concrete and a proper seal is made at the mud line. Nothing has developed during the year to alter last year's conclusions, that such cast-in-place repairs are not certainly reliable for depths in excess of fifteen feet.

Creosoted Piling

(See table 4)

In adding the additional data brought to light during the present year to the service record of creosoted piling in San Francisco Bay presented in last year's report, occasion has been taken to segregate the record of large structures according to years of installation of the piling, instead of lumping them all in one record as was done last year in the case of the Oakland Long Wharf. It is felt that such a policy will not only permit the determination of replacements by years, and thus facilitate the pursuance of

TABLE 4. CREOSOTED PILE STRUCTURES
Service Records up to December, 1921

Owners	Structure and location	Year com-pleted	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
S. P. Co.	Slip-foot of Broadway, Oak.	1898	681	681	None	Rebuilt complete 23 yrs. service.
	Slip and ways Peralta St., Oak.	1896-1902	4310	200	None	Repairs made in 1916—In use in 1921. Attacked by borers.
	Slip-Alameda	1902	600	150	None	Rebuilt after fire in 1902 leaving 150 slightly burned piles in place. Date of renewal not known.
	Car slip-Oak. Mole	1903-4	1818	None	None	50 piles in bad condition to be renewed immediately.
	Car slip-Port Costa.	1921	1721	None	New work	Replaced old slip, but in somewhat different location.
	Car slip-Benicia	1921	1499	None	New work	Replaced old slip.
	Slip-So. Vallejo	1921	788	None	New work	Replaced old slip.
	Auto slip-Oak. Mole	1921	476	None	New work	New work adjoins original pier structure.
	Long wharf "A"	1890	83*	5 useless	6 poor condition	Dock removed 1919. 66.7 per cent sound.
	Long wharf "C"	1897	523*	116 "	74 do	" " 1919. 63.6 per cent sound.
	Long wharf "D"	1899	1090*	99 "	162 do	" " 1919. 76.0 per cent sound.
	Long wharf "E"	1901	2485*	345 "	240 do	" " 1919. 76.5 per cent sound.
	Slip-Mission Bay	1904	840	840	None	Dock completely rebuilt. Dates not stated.

*Number inspected only; not necessarily total number.

TABLE 4. CREOSOTED PILE STRUCTURES—Continued.
Service Records up to December, 1921

Owners	Structure and location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
S. P. Co.	Dumbarton..	1907-10	2562	None	None	*Limnoria* attack on scattered piles.
	Slip- Oak. Mole .	1898	2880	Not stated	Not stated	No 1921 report.
Associated oil........	Port Costa...	1920	166	None	None	Replaced untreated piles.
	Port Costa...	1921	221	8	None	Replaced on account of brooming.
Cal. Wharf and Warehouse Co......	Port Costa...	1920	638	None	None	Green below mud line.
Board of State Harbor Comm'rs	Pier 36 (Ext.)	1909	570	17	118	*Limnoria* holes cemented.
	Pier 20 (Track) ...	1912	84	19	None	*Xylotrya* attack.
	Pier 16.......	1915	1881	None	289 holes	Light *Limnoria* attack in dog holes and checks.
	Pier 18.......	1915	1881	None	190 holes	" " " " " " " "
	Pier 20.......	1915	102	None	Not stated	No report 1921.
	Pier 15.	1914	1379	None	394 holes	Light *Limnoria* attack in dog holes and checks.
	Pier 19 Reconst....	1914	528	None	329 holes	Heavy *Limnoria* attack in dog and stay bolt holes.
	Pier 9 Repiling...	1911-15	1680	152	1070 holes	Patching *Limnoria* holes not yet started.
	Pier 7........	1912	986	127	None	
	Pier 28.......	1914	511	None	282 holes	Heavy *Limnoria* attack in dog and stay bolt holes.

TABLE 4. CREOSOTED PILE STRUCTURES—Continued.
Service Records up to December, 1921

Owners	Structure and location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
Harbor Comm'rs....	Pier 25 Reconst. ..	1914	714	16	455 "	Principal attack in stay bolt holes.
	Pier 27 Track......	1914	573	12	200 "	Principal attack in dog holes.
	Pier 14	1914	1557	None	481 "	Light *Limnoria* attack in dog holes and checks.
	Pier 21. Reconst....	1915	560	None	442 "	Heavy " " " " " " "
	Pier 11 Reconst....	1915	1092	None	340 "	Light " " " " " " "
	Pier 22	1615	658	None	136 "	" " " " " " " "
	Pier 24.	1915	1452	None	386 "	" " " " " " " "
Howard Co.	Oak. Estuary	1917	Not stated	None	None	Now in use.
Moore Shipbuilding..	Oak. Estuary	1921	Not stated	None	None	New work.
City of Oakland	Oak. Estuary	1916	Not stated	....	....	Apparently in good condition.

TABLE 4. CREOSOTED PILE STRUCTURES—Continued.
Service Records up to December, 1921

Owners	Structure and location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
S. P. Co.	Dumbarton..	1907-10	2562	None	None	*Limnoria* attack on scattered piles.
	Slip—Oak. Mole .	1898	2880	Not stated	Not stated	No 1921 report.
Associated oil........	Port Costa...	1920	166	None	None	Replaced untreated piles.
	Port Costa...	1921	221	8	None	Replaced on account of brooming.
Cal. Wharf and Warehouse Co......	Port Costa...	1920	638	None	None	Green below mud line.
Board of State Harbor Comm'rs	Pier 36 (Ext.)	1909	570	17	118	*Limnoria* holes cemented.
	Pier 20 (Track) . . .	1912	84	19	None	*Xylotrya* attack.
	Pier 16.......	1915	1881	None	289 holes	Light *Limnoria* attack in dog holes and checks.
	Pier 18	1915	1881	None	190 holes	" " " " " " " "
	Pier 20.......	1915	102	None	Not stated	No report 1921.
	Pier 15	1914	1379	None	394 holes	Light *Limnoria* attack in dog holes and checks.
	Pier 19 Reconst.. ..	1914	528	None	829 holes	Heavy *Limnoria* attack in dog and stay bolt holes.
	Pier 9 Repiling. ..	1911-15	1680	152	1070 holes	Patching *Limnoria* holes not yet started.
	Pier 7........	1912	986	127	None	
	Pier 28.	1914	511	None	282 holes	Heavy *Limnoria* attack in dog and stay bolt holes.

TABLE 4. CREOSOTED PILE STRUCTURES—Continued.
Service Records up to December, 1921

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Harbor Comm'rs....	Pier 25 Reconst. ..	1914	714	16	455 "	Principal attack in stay bolt holes.
	Pier 27 Track......	1914	573	12	200 "	Principal attack in dog holes.
	Pier 14.......	1914	1557	None	481 "	Light *Limnoria* attack in dog holes and checks.
	Pier 21. Reconst....	1915	560	None	442 "	Heavy " " " " " " "
	Pier 11 Reconst....	1915	1092	None	340 "	Light " " " " " " "
	Pier 22	1615	658	None	136 "	" " " " " " " "
	Pier 24.......	1915	1452	None	386 "	" " " " " " " "
Howard Co..........	Oak. Estuary	1917	Not stated	None	None	Now in use.
Moore Shipbuilding..	Oak. Estuary	1921	Not stated	None	None	New work.
City of Oakland	Oak. Estuary	1916	Not stated	....	....	Apparently in good condition.

TABLE 4. CREOSOTED PILE STRUCTURES—Concluded

Service Records up to December, 1921

Owners	Structure and Location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
S. F.—Oak. T. Railways	Terminal Tracks 1, 2, and 3	1912-13	261	None	None	Replaced concrete cylinder. Piles still in service.
	Train Shed	1913-14	293	None	None	Replaced concrete cylinders. Piles still in service.
	Side Wharves	1913-14	307	None	None	Replaced Paraffine paint piles. Piles still in service.
	Terminal	1914-15	1842	None	None	Replaced Paraffine paint piles. Piles still in service.
	Old Trestle Stub	1914	425	None	None	Replaced Columbia paint piles. Piles still in service.
	New Trestle	1914-15	2192	None	None	Still in service.
	New Slip	1914-15	802	None	None	Still in service.
U. S. Navy	Causeway	1921	702	None	New wor	Replaced untreated piles.
	Ammunition Pier 1	1921	398	None	New work	" " "
	Ammunition Pier 3	1921	261	None	New work	" " "

maintenance and depreciation studies, but will prove a valuable safeguard against drawing erroneous conclusions in respect to the life of any class of piling.

Service records are entered this year for 30 installations not entered in last year's report, involving over 23,000 piles in 27 installations, with 3 installations for which it has not yet been possible to obtain the exact data on number of piles installed. This data, however, is in most cases promised and will be obtained, it is hoped, in the further progress of the work. There are also certain unavoidable discrepancies between this report and last year's in the number of piles entered for some of the structures covered by both reports. This year, also, the policy has been adopted of using only the service record of bearing piles, since fender piles, of which many were entered in the record of last year, are subject to such special hazards as seldom or never to show a life which is representative of the service rendered by the same class of pile in bearing service.

Perhaps the most important result of the increased volume of service records presented this year is that the average life of creosoted piling indicated by them is lower than that recorded last year. This does not, in the view of the Committee, indicate that creosote treatment is less valuable than was stated in last year's report, although the statement of the Committee last year has been misinterpreted in some quarters as promising for creosoted Douglas fir piling, as now used, or for structures as a whole, the extreme life shown by the best examples taken from the Oakland Long Wharf. Creosoted piling as now commonly found in marine structures is far from being piling "properly handled in rafting, and not mistreated in the erection of the substructure" which was predicated in the last year's statement of the Committee.

Rather, in view of the very striking evidence given by the Harbor Commission report, that of all the damage to piling noted and repaired in this year's complete inspection 80 per cent was definitely caused by dog holes, (plate 4, fig. 2) through which the borers plainly gained their entrance, do the service records now presented strengthen the emphasis laid last year upon the critical necessity of care, both in the handling of creosoted piling from the treating plant to the structure and in driving it and building the superstructure upon it. Unquestionably the use of poor oil or improper methods of treatment may also shorten the life of creosoted piling and should be guarded against by proper specifications. Thin treatment on one side of the pile (plate 5, figs. 1 and 2; plate 6, figs. 1 and 2) sometimes results when the piles are rafted before being treated, if the moisture is not properly removed in the treating process. The evidence also thoroughly established that knots frequently afford points of entrance for borers. (Plate 7, fig. 1.) The evidence of such examples as the Oakland Long Wharf as to the life which a proper creosote treatment, properly safeguarded in subsequent handling and construction, may give to wooden piling still stands. Creosoted piling is a highly specialized product, and like all such products its adaptation to a special purpose involves greater care in protecting it against other conditions. But the very greatly increased resistance *against marine borers* given to wooden piling by good creosote treatment is certainly worth the price which must be paid for it in protecting it from mechanical damage.

It seems justified again to emphasize the statement of last year that a great need of the San Francisco Bay region is a creosoting plant in this vicinity. A part of the remarkable record shown by the Long Wharf piling was unquestionably that it was possible to creosote it in the Company's own plant close to the point where the piling was to be installed, thus minimizing handling damage. The rafting, storage and repeated handling, almost universally accompanied by dogging, which is incident to obtaining piling at a distance, makes damage from such sources almost impossible to prevent; and this is the position occupied by all users of creosoted piling in the Bay region, except the Southern Pacific Company, to whom the Long Wharf belonged. It is not surprising, therefore, that the Harbor Commission found 80 per cent of all damages occasioned by dogging.

In the case of creosoted piling, as in that of other forms of piling, the Committee feels that the volume of service records so far accumulated does not represent a sufficient proportion of the whole body of structures in this territory to warrant the stating of an average life. A conclusion respecting the range of life which may reasonably be expected from creosoted Douglas fir piling in this region *under existing conditions* may, however, be legitimately drawn, and will be found in the summary at the end of this section of the report, for this as for other types of piling.

Reinforced Concrete Cylinders

(See table 5)

The information contained in the 1921 report regarding this type of construction has been amplified by a detailed record of repairs to existing structures on the San Francisco Waterfront (plate 7, fig. 2). The defects noted appear to be the result of insufficient and improper tamping and of negligence in cleaning construction joints where concreting was discontinued (plate 8, fig. 1). In both cases the negligence was aggravated by the use of excessively wet consistencies of concrete which have been conclusively proven to

TABLE 5. REINFORCED CONCRETE CYLINDERS PLACED IN OPEN CAISSONS

Service Records up to December, 1921

Owners	Structure and location	Year com-pleted	No. of bearing cylinders	No. of cylinders replaced	No. of cylinders repaired	Remarks
Board of State	Pier 36	1909	427	None	10	3 in. concrete shell encases defects
Harbor Comm'rs	Pier 38	1909	437	None	47	3 in. concrete shell encases defects
	Pier 40	1909	440	None	51	3 in. concrete shell encases defects
	Pier 28	1912-13	451	None	142	Joints at low water grouted
					76	3 in. concrete shell encases defects
	Pier 26.	1912-13	664	None	27	3 in. concrete shell encases defects
					161	Joints at low water grouted
	Pier 39.	1913	531	None	None	No repairs to date—some patching necessary
	Pier 30-32	1913	1509	None	None	Concrete sound—no disintegration
U. S. Q. M. C..........	Transport docks	1911	Not stated	None	None	Inspection shows good condition

produce inferior concrete, and which, although once considered good practice, are no longer permitted in the best modern practice. Owing to the massiveness of the columns, no defects have developed to date which materially affect the structural stability of the piers. Defective construction joints have been repaired by pointing and grouting, and inferior concrete by encasing the cylinder in a shell of dense concrete. The cylinders of the U. S. Army Transport Docks at Fort Mason and of Piers 30–32 and 39 are in first class condition and indicate the possibilities of this type of support when properly designed and when construction conditions are favorable.

Reinforced Concrete Piles

(See table 6)

The square reinforced concrete pile with chamfered corners described in detail in the 1921 report has become a standardized construction type for the San Francisco Bay region (plate 8, fig. 2, and plate 9, fig. 1). Of the numerous installations made during the past ten years, no defects have been noted in the portion of the piling below high water. In the older structures, however, cracks due to the rusting of embedded steel are beginning to appear between the high water line and the deck. In this portion of the pile they are easily observed and readily repaired as contrasted to deterioration below the low water line which cannot be observed. The real concern of engineers experienced with this type of construction is not so much with the pile as with the concrete decks which usually accompany concrete pile construction. The Board of State Harbor Commissioners is keeping a careful record of such deterioration, a portion of which relating to piles is recorded as a service record. As a result of experiments and observations, the engineers of the Board are confident that in all future construction, deterioration due to rusting of embedded steel can be retarded if not prevented by several simple expedients, such as the use of galvanized steel, and periodic coating of the concrete surfaces with asphalt, paraffin or other waterproofing coatings.

With reference to both reinforced concrete cylinder and reinforced concrete pile construction, many engineers are of the opinion that the increased cost of this construction is not justified by the degree of permanence so far exhibited. The principal factor which has influenced the early development of this construction in this locality has been the demand for fireproofing in waterfront structures where cargoes are concentrated aggregating in value many times the cost of the structures. As frequently happens, the pioneer has paid heavily for the experience of blazing the way. All the early structures were built before the modern scientific studies of con-

TABLE 6. REINFORCED CONCRETE PILES

Service Records up to December 1921

Owners	Structure and Location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
Board of State Harbor Com'rs	Bulkhead 17.	1911	135	None	None	41 piles show rust cracks above H. W.
	Seawall 11A..	1912	141	None	None	36 " " " " " "
	Pier 35........	1915	2492	None	None	56 piles badly cracked above H. W.
						215 piles slightly cracked above H. W.
City of Oakland......	Livingston St..........	1912	Not stated..	None	None	No evidence of failure in piles.
S. F.—Oak. T. Railway................	Apron........	1915	28	None	None	In place and in good condition.

TABLE 7. METAL SUPPORTS

Service Records up to December, 1921

Owners	Structure and Location	Year completed	No. of bearing piles	No. of piles replaced	No. of piles repaired	Remarks
Q. M. Dock..........	Ft. Mason....	1886	86	None	None	W. I. Pipe 10"—No. 1921 report.
	Alcatraz.....	1870	69	Not stated	Not stated	C. I. Pipe 12" " " "
	"	1900	139	" "	" "	C. I. Pipe 8" " " "
	"	1906	Not stated	" "	" "	C. I. Pipe 8" " " "
	Ft. McDowell E.......	1903	55	" "	" "	C. I. Pipe 10" " " "
	Ft. McDowell W......	1883	714	" "	" "	C. I. Pipe 10" " " "
	F. Baker.....	1891	54	None	" "	C. I. Pipe 10" " " "
	Presidio......	1890	122	None	" "	C. I. Pipe 10" " " "
U. S. Lighthouse......	Goat Island..	1897	93	None	Painted only	12" lap welded, 3/8" thick—good condition.

crete construction were disseminated, at a time when the danger of excessive water and sand contents were not merely unknown but were even thought beneficial and when concrete of any thickness was considered an efficient protection for the corrosion of steel.

Notwithstanding defects which will admittedly lessen the durability of these structures, their value has been enhanced by the progressive rise in construction costs, a tendency which is seldom taken into account by advocates of more temporary construction. In general it may be stated that high class reinforced concrete cylinder and reinforced concrete pile construction on San Francisco Bay gives promise of outlasting other types of sub-structure support with the exception of mass concrete construction. It is necessarily limited by high cost to structures in which long economic life, fire risk or difficulty of replacement justifies increased expense.

Standardized Service Records

The experience of the present year has strengthened the conviction of the Committee respecting the wisdom of the recommendation made last year for the standardization of service records of marine piling. The scope of the information respecting the history of piling, through treatment or fabrication, handling and installation, as well as subsequent inspection and repair or replacement, which is needed for adequate interpretation and the greatest usefulness of service records has increased with the study devoted to the subject. Present methods in respect to service records are of all degrees of incompleteness, as well as of lack of uniformity in the information which is recorded. Much of the information which would now be valuable and which the Committee would like to obtain respecting piling installed in the past is doubtless irretrievably lost.

No engineer who has studied the matter, however, can doubt that the keeping of adequate service records would save many times their extra cost to any company, in the information preserved for future guidance in design and contracts. Nor can he doubt that if such records were kept on a mutually consistent basis and in harmonious form, for the majority of marine structures in San Francisco Bay, their value for future cooperative studies would be very great, in contributing to the improvement of future piling and the increasing of its service life.

The diversity of the needs of different concerns and their financial limitations on the extent to which they can go, as well as the individual preferences of engineers, make the specific organization of service record system a matter which must largely be worked out for each individual case. That greater harmony is desirable no one can doubt.

As to method, any recommendation toward this end must await more intensive and detailed study than has yet been given to the subject. In the meantime, however, much can be done toward increasing the adequacy of service records by a study on the part of engineers of the possibility of incorporating in their records items not now recorded but for which it is seen (by even such limited questionnaires as the one which this Committee now presents) that there will be future need. It is believed that a helpful scheme, often missing in service record systems, is a service record central correlating or index file, through which all service record data can be located, data which for any reason must be filed elsewhere being represented by cross reference. The Committee's service record report form, it is hoped, may offer some ideas in regard to the contents and organization of such a file.

Summary of Conclusions

In concluding the service records section it seems desirable to restate the summary given in the report of last year, with the modifications which seem to be required as the result of this year's work. All changes of wording from that used last year are indicated by *italics*.

(1) Marine borers are very active in San Francisco Bay and connected waters, and in places where their attack is severe will destroy untreated piling in as short a time as six to eight months. In other places the untreated piling may last from two to four years.

(2) The information secured indicates that it is reasonable to expect a life of five to eight years from paint and batten protections *in sheltered waters*, if the work is well done. If it is not well done, or if the covering is damaged by careless handling *or if unprotected wood is exposed by mud scour*, this range of life cannot be expected.

(3) *The data so far in hand indicates that it is fair to expect creosoted Douglas fir piling in San Francisco Bay to give a life of 15 to 20 years under present conditions. Certain piles are of authentic record from the Oakland Long Wharf which were sound when removed after a service of 29 years. Poor treatment, or damage to creosoted piling by careless handling, rafting, storage or construction, will materially reduce the life which might otherwise be rendered by such piling.*

(4) Most of the attack on creosoted piling by marine borers, which the Committee has observed throughout this survey, appears

to have begun in spots where untreated wood has been exposed by damage in handling the piles or placing the superstructure. It is urgently recommended that improvements be made in the methods of handling creosoted piles and building structures upon them, so that damage to the surface of the piles may be reduced to a minimum.

(5) Precast reinforced concrete piles and pile casings have not been in use in San Francisco Bay a sufficient length of time to determine their ultimate life. A detailed examination of those structures which have been in service for 10 years shows no evidence of deterioration *below high water line*, and they seem capable of a long further life. The length of life to be expected from this type of construction is largely dependent upon the quality of materials and workmanship and the skill and care with which they are employed; and any laxity in these particulars will materially shorten the length of service which may be secured.

(6) *Reinforced concrete cylinders cast in open caissons have been in use for twelve years. Although the average life of many earlier cylinders has been considerably shortened by construction defects, these cylinders with minor repairs still give promise of a long period of service. Similar cylinders designed and constructed in accordance with best modern concrete practice should constitute a type of construction only excelled for longevity by solid fill or mass concrete.*

(7) Cast in place concrete pile jackets may be expected to give satisfactory results if properly constructed of suitable materials *and proper regard is given toward exclusion of sea water from forms.* The difficulties of this type of construction, however, are of such a nature that the probability of securing a maximum length of life is less than in the case of precast concrete piles or pile casings. (No. 6 in last year's summary.)

(8) *Copper sheathed piles have given very satisfactory service in locations where damage from abrasion and theft can be minimized. Such piles carefully prepared and handled fall into the class of best surface protections, when used under the conditions indicated.*

(9) The selection of a type of piling or pile protection for a given structure must be made upon the basis of cost and permanence of the materials under consideration, the character of the structure and the probable need for future alterations to meet the changing requirements of commerce. When a comparatively short increase over the life of *untreated* wooden piling is sufficient, the surface protections will often be found economical in waters not exposed to severe storm action; if a moderately long physical life

approximating the average economic life of marine structures in this harbor is desired, a good creosote treatment will provide it at the lowest annual cost so far as present knowledge goes; if conditions warrant building for the greatest permanence, with less regard for first cost, concrete construction *has shown a high value in this harbor.* For the protection from further damage of wooden piles already in place and showing attack by borers, not yet severe enough to require condemnation, the concrete casing, precast or poured in place, is the only means of salvage so far found by the Committee.

Form of Service Record Reports to the Committee

For the purpose of service record reports desired by this Committee the following revised form will be used in the future. It will be mimeographed so that it can be sent out by the Committee for execution and return. The form has been restricted in the data requested to what has seemed the lowest possible limits, in view of the constantly increasing range of information which continued study of service record problems raises. Information on a few points may not be available for structures of many years' standing; but it is hoped that cooperators can keep substantially such data in future records, in view of the very great value which ten years' keeping of such information throughout the Bay region will have. In filling out the form it is hoped that on certain items such as concrete manufacture, creosote treatment, etc., detailed information will be furnished when it is available, as indicated in the footnote of the form, using separate sheets wherever necessary, properly referenced to the form.

SERVICE RECORD REPORT

To the S. F. Bay Marine Piling Committee.

I. *Statistical Data:*
  a. Owner: Name: ....
    Address: Street .... City .... Calif.
  b. Person in charge:
    Name: ....
    Address: Street .... City .... Calif.
    Phone: ....
  c. Location: ....
  d. Name of structure: ....

II. *Construction Data:*
  a. Type of structure: ....
  b. General dimensions: L.... x B.... Can you supply a plan?...
  c. Distance of deck above high tide: ....
  d. Average depth of water...... Can you supply profiles?.....
  e. Kind of bearing pile: ....

f. * Treatment of wooden piles: Method ....
By whom ....
g. * Composition of concrete. Mixture.......Reinforcement.......
Seasoning time allowed: ....
h. Number of bearing piles: ....
i. Date of completion: ....

III. *Exposure Data:*
a. Distance to nearest structures: ....
b. Do you keep a salinity record? ....Will you? ....
c. Sewage or other local contamination: ....
d. Borer most numerous: ....
e. Position with reference to shore: ....
f. Tidal and current conditions: ....

IV. *Repair Data:* (Furnish layout plan).
a. Repairs: Date:........ Number:........ Nature:* ....
b. Replacements: Date:....... Number:....... Kind:..........
* If wooden piles: Treatment (By whom:..........
(Method: ....
* If concrete comp.: (Proportions: ....
(Reinforcement: ....
(Seasoning time: ....

V. *Inspection Data:* (Furnish layout plan).
a. Date: ....
b. By whom performed: ....
c. Nature of deterioration: Mech'n'l. Damage:..Decay:..Borers:..

VI. Have you photographs illustrating points of interest under any of the above headings? ....
Report made by ....
Title ....
Place ....
Date ....

* For items thus indicated, as detailed information as possible is desired. For example, for creosoted piles it is of great value to know the origin and analysis of the oil used in treatment, whether the piles were water stored before treatment, etc. Use extra sheet if necessary.

WHARF CONSTRUCTION SECTION

Following this Committee's report of last year an insistent demand arose, of which one phase concerned the formulation by the Committee of definite advice respecting practical measures which should be taken to avoid, for example, the damage to creosoted piling in careless handling and construction which the report of the Committee so strongly condemned. This led to the creation for this year of the subcommittee on Wharf Construction.

Specifications and Inspections

It should be obvious that specifications and inspections should be co-extensive. The best specification is comparatively valueless unless inspection is both thorough, and of sufficient scope to insure that the specification has been complied with. With respect to piling this should follow through the supply and preparation of the piles, their transfer from source of supply to site, their handling to pile driver, and finally their driving and fastening in the completed structure. The suggestions herein offered are confined to creosoted piling, for which a suggested specification is presented in the specifications section of this report. The Committee believes that the best insurance of right results is to have inspection of creosoted piling for final acceptance done as it hangs in the driver gins, where every defect may be seen and examined.

Preparation and Treatment

Creosoted piling should be carefully inspected at the creosoting plant, as to the dimensions, form and condition of the piling used, and during treatment especially as to the oils, to see that they are free from adulterants and otherwise fulfill specifications, and as to the penetration of the piling by the oil as required. Creosoted piles should be bored in the course of inspection, in accordance with the tentative specifications presented in this report.

Handling Creosoted Piling

After having the piling properly treated it is equally important that it be carefully handled from the treating plant to the job. Too much emphasis cannot be placed on the handling and care of creosoted piling. Once the outer protective shell is penetrated the value of the pile is largely destroyed unless the defect is repaired.

It is very unfortunate that there is no commercial creosoting plant located on San Francisco Bay. At present it is necessary to purchase all of these materials from the plants located in the Northwest, involving a maximum amount of transportation and handling and consequent damage. Being so far from the source of supply, it is necessary to keep creosoted piling on hand at all times, which also adds to its chances of being damaged before being used. All of this handling and storage makes it very difficult to avoid damaging piles.

The work of this Committee will have been more than repaid if a treating plant should locate in the Bay region. In fact, it would be economical to pay premiums to have piles treated locally, as they are required for use. Of the creosoted piles driven in structures of Long Wharf, 13,000 pieces, or about 93 percent were treated at the Southern Pacific Creosoting Plant at West Oakland, and an average of about 30 per cent of all the piles in the structure were subjected to attack by marine borers on account of physical damage to the protective shell. These piles received a minimum of handling to the job, yet this large number were found to be damaged. The extent of damage is likely to be in direct relation to the extent to which it is necessary to handle the piles.

Recently a pile-driving crew in this Bay had a raft of creosoted piling dogged in the center of the raft. (Plate 9, fig. 2.) As the raftsman worked the piles out of the raft up to the driver, he drove dogs into the piles at five different points in their length. It has been a common sight to see rafts of creosoted piling dogged diagonally across, each pile being permanently damaged, as the holes made by the dogs are rarely plugged. The dog is by far the worst enemy of creosoted piling, as is definitely shown, it is believed for the first time, in the service record report of the Board of State Harbor Commissioners which has been presented in this report. Their use should be unconditionally prohibited, except within specified distances of either end which will allow ample margin to protect the water section of the pile. When creosoted piles are prepared for towing considerable distance boring and reeving should be the only method of fastening allowed. The ax, the pike pole and the peavie also cause much damage. The holes left by sinking an ax in the piling, as is frequently done in handling, are much like those caused by the dog, and are particularly dangerous. The use of pike poles and peavies should only be permitted when their points are blunted. The use of boat hooks during inspections by row boat or raft is also a source of considerable damage to treated piles in place and should be prohibited.

Construction

DRIVING CREOSOTED PILING. Again it is necessary to take precautions against the puncturing of the protective shell with pike poles, peavies, axes, etc. Unfortunately men handling creosoted lumber and piling do not appreciate the necessity for preserving the protective shell. Eternal vigilance is the price of a good job in this respect.

One of the most important duties of the pile-driving crew is to drive the piles without puncturing the protective shell. There is always danger of checking the piling under the hammer. In using a steam hammer it is well to use piles of a minimum butt diameter of 14 inches. This permits the pile to be headed, trimming off all creosoted material so that the plate upon which the plunger strikes rests entirely on untreated wood and is not so likely to cause checking. On rocky bottoms, where there is little or no mud, great care must be taken not to split the pile (plate 10, figs. 1 and 2). This can be done by avoiding hard driving, and by the use of various types of steel shoes and plates.

CUTTING OFF PILES. Creosoted piling should not be cut off below high water line, thus exposing untreated wood to attack by borers, if it can be avoided. Even tide slopping, (plate 11, fig. 1,) where piling is cut near to high water level, may permit *Limnoria* attack, if water can settle where it does not run off. Furthermore, decay frequently occurs in the untreated interior of piles when they are cut off at any level above high water. Whenever piles are cut off, therefore, the untreated wood should be protected by thoroughly painting the top of the cut-off portion with hot creosote. Above the water line, a further coating of thick asphalt may be applied, to prevent the penetration of moisture; below water line the access of borers can be prevented by covering tightly with sheet copper.

BRACING, RIBBING, ETC. The only safe way is to have all bracing, ribbing and other construction attachments well above high water (plate 11, fig. 2.) Where this cannot be done, dapping the piles, (plate 12, fig. 2) which exposes untreated wood, should be prohibited, except where it is absolutely unavoidable, letting necessary cutting or framing be done, so far as possible on the pieces to be attached to the pile, (plate 12, fig. 1; plate 13, fig. 1; plate 14, fig. 1) since they are cheaper to renew. The braces, ribbing and other attachment members should be creosoted if they will be exposed to borer attack, and all boring and framing which can possibly be done in advance should be done before the members are creosoted. Otherwise all such holes or framing cuttings should be well swabbed with hot creosote before putting the parts into the construction. All holes for bolts or pins should be bored not larger in diameter than the bolt or pin, to insure a driving fit. This will prevent borers from entering the bolt holes, so far as it is possible to provide against it. (Plate 12, fig. 1; plate 13; plate 14.)

FENDER LINES. Fender lines are always constructed of wooden piling, usually untreated in this region but sometimes treated. Connections to treated piling below the water line, where such connections expose untreated material, are dangerous. Bolt and spike holes provide a ready means for borers to enter. Where it is necessary to bore holes in creosoted fender piling the holes should be bored for a driving fit, as above indicated for bracing.

Repairing Damaged Piles

When a treated pile is damaged it should be immediately repaired. Holes should be plugged with creosoted material, and where repairs cannot be made in this way the damaged place should be covered with sheet copper. The Board of State Harbor Commissioners have recently been filling such holes, as well as those of the initial attacks of *Limnoria* working in them, with cement mortar. It is too early to judge the effectiveness of the method, but it looks promising.

Removing Breeding Grounds

As a means of removing the breeding grounds of marine borers, not only should the use be avoided, so far as practicable, of untreated wood in waters infested by marine borers, but shores should be kept clean of drift-wood or other wooden debris, and pile stumps and similar debris removed thoroughly from the sites of dismantled or abandoned structures. This seems to be a practicable way of reducing progressively the severity of the annual attacks which follow the breeding season, in the fall of each year in this harbor. This matter was emphasized last year in the biological report of Dr. Charles A. Kofoid, but its importance is felt to warrant its repetition in the present connection. So important is it that the enactment of legislation for enforcing such marine sanitation is a most urgent need.

Practical Difficulties

Any such program as that above outlined will doubtless inconvenience those engaged in the handling of piling or the erection of piling structures, and may increase the cost of their work. It thus may cause irritation, or even evasion of instructions, alike on the part of contractors and workmen who are used to more lax methods. Much can be done to help, by personal explanation and discussion, as a supplement to specifications or instruction orders, especially with respect to care in handling, and it is time well spent for an engineer to seek in this way to enlist the cooperation of rafting and construction crews. Eternal vigilance is the price of safety in this respect. Inspection of piling in the gins, which has been recommended, takes more time. It is thus likely both to be opposed by contractors and evaded by inspectors, and can only be secured by continuous insistence. But its results would be worth its cost.

Additional cost, if any, must of course be paid for; but if requirements are plainly stated in the specifications upon which bids are taken, all bidders are on the same footing. Contractors cannot afford to scrap valuable material such as piling, which they have bought in good faith under previous conditions of practice, because of new restrictions. The increased cost of getting new requirements fulfilled will be lessened, as well as the danger of having rejected piling slipped in again, if provision is made for the acceptance of piling rejected because of dog holes or similar injuries when properly repaired.

While carelessness as to penetration of the creosoted shell of piling, in both handling and construction, has been universal in the past, better practice is already appearing. The Committee is gratified to have been informed of many cases in which this better practice has been directly due to its work and report of last year. Many concerns in this region are now rejecting piles which show holes made by dogs. The Board of State Harbor Commissioners now permits the dogging of no piles, green or creosoted, except within 3 feet of the butt or 10 feet of the tip. These particular limits are dictated by local conditions of driving depth, etc. The general principle should be to prohibit such dogging within the water section, with an additional margin sufficient for safety.

PROTECTIONS SECTION

The object of the creation by the Committee of a Subcommittee on Protections was primarily to install under the supervision of the Committee test specimens of various methods for protecting wooden piling, most of which have not been in use for a long enough time to make service records available. These methods are mainly, although not exclusively, of the class of paint and batten surface protections, and most of them involve materials of patented or secret composition. Their number is considerable, and the insistence with which they are being promoted in this region creates a need among users of piling for such information as can be obtained, on unprejudiced and reliable authority, for the appraisal of values.

Progress in this work has been delayed by several unfortunate difficulties. Material for installations of a number of protective processes which are under negotiation is still to be received, either in whole or in part. This is true of two cases involving impregnation of the wood with new substances, of eastern origin, of one of which a test by the Committee was requested by a member of the American Wood-Preservers' Association. The tests already in place include also specimens of two untreated foreign woods said to have a high resistance to marine borers. These are turpentine wood and tallow wood, from Australia or New Zealand. For the former, in particular, extraordinary claims are made from many credible sources familiar with the wood.

Complete results from tests such as these can of course be expected only after a period of a number of years. In some cases, however, the occurrence of settlement or initial attack by marine borers, if present, should be evident in a much shorter time.

CHEMICAL SECTION

The work of the Chemical Subcommittee and the Committee chemist has thus far been confined to the problems connected with the preservation of wood from marine borers, no attempt having been made to attack problems raised by the disintegration of concrete in sea water or by the corrosion of reinforcing steel and various other materials. Within the field indicated, only those preservatives or preservative methods have been considered which involve penetration of the preservative into the wood. This has naturally resulted in centering much of the work upon coal tar creosote.

The investigative work so far undertaken or planned is in the following directions:

1. Studies contributing to the determination of the constituents of creosote which are the active bases of its preservative power. This involves:
   a. Laboratory separation, from original creosote oils, of certain constituents or constituent groups (oil fractions), and the preparation for each kind of oil of two sets of test timbers, impregnated respectively with the whole oil from which the given fraction has been removed, and the whole oil having the same fraction added to it.
   b. Cooperation with the Forest Products Laboratory of the U. S. Forest Service in the experimental work which is being carried on at Madison, Wisconsin, by its creosote chemist, Mr. Ernest Bateman, in the determination of the solubility partition of certain constituents of creosote (with reference to solution in the whole oil as compared with water), and of the toxicity of these constituents in varying concentrations in "barren oil," or the non-toxic portion of creosote oil.
2. Determination of the laws governing both the absorption and adsorption of creosote in wood, when the wood is exposed to air. This experiment will also be used to determine, so far as possible. the nature and extent of the loss by selective evaporation of creosote oil from wood when exposed in air.
3. Determination of the laws governing the loss of absorbed (free) and adsorbed (fixed) creosote components from wood when exposed in salt water.
4. An investigation of the variation in composition of creosote oil in wood with varying depth of penetration.
5. Investigation of certain inorganic inhibitants or poisons.

SCHEDULE 1. The experimental test timbers indicated for 1-a, are of rather large size, designed for exposure in Bay waters under as nearly service conditions as possible. Five, and in some cases six, pieces were subjected to the same treatment, one each for four different stations in the Bay, with one or two for laboratory use. There were sixteen different treatments, which were synthesized according to the following table:

Fraction A (210°–235°C)
Fraction B (235°–315°C)
Fraction C (315°–355°C)
Fraction D (Residue above 355°C)
Whole creosote oil.

Whole oil+fraction A.
Whole oil+fraction B.
Whole oil+fraction C.
Whole oil+fraction D.
Whole oil—fraction A.
Whole oil—fraction B.
Whole oil—fraction C.
Whole oil—fraction D.
Whole oil—tar acids.
Fraction D (repeated).
Oil tar distillate.

These oils were synthesized so that the several fractions were added or subtracted in the proportions in which they occurred in the whole oil, which were the following:

Fraction 210°-235°C	10 per cent
Fraction 235°-315°C	40 per cent
Fraction 315°-355°C	23 per cent
Residue above 355°C	27 per cent

In view of the difficulties incident to obtaining clear-cut separations by fractional distillation, and consequently to obtaining clearly marked differences in inhibitive or destructive effects upon living organisms, it was felt that the doubling of effect gained by both adding and subtracting the required fraction in each case to the whole oil might so increase the decisiveness of this general method as to make it yield useful results. A piece of untreated wood was attached as a bait to each of those treated and a set of eight specimens so prepared was placed in a rack. Racks containing test pieces of each of the sixteen different treatments are now in place at the following stations in the Bay: San Francisco Pier 7, Southern Pacific Oakland Pier, Mare Island, and Crockett. An analysis of the oil from each of the runs has been made, as well as of that extracted from one of the test pieces after treatment. Similar extractions will be made of the oil of each of the test pieces, as they are removed from time to time.

In addition to the rough indication of the relative value of the fractions of creosote, and possible guidance in respect to creosote fortification, which it seems legitimate to hope for from this series of experiments, it has already proved of much value in furnishing information for the guidance of the more carefully controlled series of experiments indicated under schedules 2 and 3.

In respect to schedule 1-b, this Committee in the co-operation with the Forest Products Laboratory will be expected to give specific attention to the tar bases, endeavoring to develop for them more accurate methods of analysis than are now available, as well as preparing four specific bases and determining their solubility in water. Toxicity tests will be carried on, in conjunction, by the Biological and Chemical Subcommittees, on various creosote constituents, with reference to marine borers. In addition to their direct value in the study of marine protection, these tests will afford a valuable comparison between the toxicities of the materials tested, on marine borers and fungi, respectively.

SCHEDULES 2 AND 3. The tests under these schedules are kept under much more careful control than are those of schedule 1-a. This series of experiments should show what constituents of creosote become fixed in wood, what are not fixed, what vaporize out and what dissolve away. The chemical constituents of the wood will also be studied, as well as that of the creosote, so far as that may appear profitable to the main problems in hand.

The test pieces for these experiments so far prepared are of Douglas fir sapling, about 5 inches in diameter and 6 inches long. They are weighed with an accuracy of 0.1 per cent and are now being treated with a good creosote oil. The size of pieces is sufficient to absorb oil enough for a complete analysis on being extracted, and yet small enough so that the whole piece can be made into shavings and thus carried through the experiment, which is necessary to obtain data of sufficient accuracy for this study.

One piece will be used for the immediate extraction of its oil; two pieces will be placed in the air; and seven in the Bay, for removal and inspection or analysis from time to time. Sawdust representative of the wood used for the test pieces is being analyzed as to its composition, and some of the test pieces will be analyzed after extraction of their oil, to determine whether treatment and exposure have made any change in the wood composition.

These two series should give information regarding the physical and chemical nature of changes occurring in both the creosote and the wood, under exposure of treated wood in air and water, respectively, and regarding the relation of these changes to the creosote held in the wood by absorption and adsorption, respectively. In particular, its recorded compositions should permit a sufficiently accurate determination of the time-loss curves, both as to quantity and character of creosote lost from treated wood; which certain evidence seems to indicate may be a critical factor in the explanation of the mechanism of creosote protection.

Analyses have been made by the Committee chemist of oils extracted from piles which had been in service for periods of from one to thirty years. The short-service piles used for analysis had been treated and driven in recent years, and analyses of the original oils with which they had been treated were available. The long-service piling used was from Oakland Long Wharf. It is recognized that the methods of analyzing extracted oils so far used involve certain elements of possible error; but the analyses made by the Committee were identical in method, and checked very closely in results, with those reported to this Association in 1920. Comparison of the analyses made by the Committee seems provisionally to indicate that the oils extracted from piling of as short service as one year had already lost light oils and reached a composition closely similar to that shown by the Long Wharf piling after 29 years' exposure.

Work is already in progress in schedules 1-a, 2 and 3 above listed. Work is projected in 1-b, 4, and 5, and the mutual agreement is being reached with respect to the details of the former. On the work already started it is believed that preliminary results of some value should be available by June 30, 1922.

MISCELLANEOUS. Besides the work listed above, numerous analyses have been made of whole oils or fractions of them, as well as of extracted oils from service piling; most of which have been done cooperatively, for the Subcommittee having in charge the formulation of a tentative specification for creosote oil for the preservation of marine piling. Special mention may be made of the analysis of a sample of the oil-gas tar creosote which is mentioned in the Specifications Section of this report. This analysis showed the following results:

Specific gravity at 38° C.	1.112
Fractionation:	
0°–210° C.	0.0 per cent
210°–235° C.	24.7 “ “
235°–315° C.	11.3 “ “
315°–355° C.	7.3 “ “
Residue above 355° C.	54.8 “ “
Loss by volatilization	1.9 “ “
	100.0 per cent
Specific gravity of fraction 235° C.–315° C. at 38° C.	1.056
Specific gravity of fraction 315° C.–355° C. at 38° C.	1.094
Tar acids	None
Unsulfonated residue	None
Insoluble in benzol	0.24

Float tests of residue above 355° C., 5 seconds.

Remarks: Coke test was negative, no true coke being separable in the residue.

SPECIFICATIONS SECTION

The tentative specification covering creosoted piling and lumber for use in marine structures which is herewith presented was undertaken by the Committee only in response to insistent demands on the part of contributors to the support of the Committee, and other local cooperators, to whom the Committee was under primary obligation. The Committee keenly realizes that the incompleteness of present knowledge will make the establishment of satisfactory standards impossible until results become available of further investigations such as those now being undertaken by cooperating agencies throughout the country, of which this Committee is one. But those who are responsible for the installation and maintenance of marine piling feel equally keenly the need of the best guidance which present knowledge can supply for their current purchases of creosoted materials.

The work of the Committee up to the present time has seemed to indicate that certain factors existing in this region make desirable, even in the light of present knowledge, certain modifications in existing specifications, in order to insure for marine construction a creosote oil which shall be best suited to this specific purpose. The specification is necessarily tentative and has been formulated specifically for local needs. It is expected that it will be amended and improved as further knowledge becomes available.

The specification as presented is practically the same as those in current use, excepting in the creosote oil section, whose modifications from existing specifications have been referred to. The chief considerations with reference to local conditions which seem to require modification of existing specifications, such as the standard specification of this Association covering creosote for ties and structural timbers, are the following:

1. OIL TAR CREOSOTES. Such creosote is now being offered for wood preservation use on the Pacific Coast. Repeated analyses show that it will pass every test embodied in the standard specification,.except the requirement as to origin. (See analysis at end of chemical section of this report.) It is well known, however, that such oils do not contain the tar acids which characterize coal tar creosote. In order, therefore, to provide a test for the compliance of oils with the requirement of origin it has seemed necessary in this Committee's tentative specification to restore the tar acid clause which was formerly in common use but has been omitted from the specifications of recent years. It is recognized that there is no con-

clusive evidence of lack of preservative value in oil tar creosotes, which have a composition so closely similar to that of coal tar creosote; and some investigations in this direction are being undertaken by the Committee. The Committee heartily shares, however, the feeling now widely held with respect to specifications for wood preserving creosotes, that, in view of the lack of authoritative knowledge of the effective constituents in such creosotes and the mechanism of their preservative action, it is the part of wisdom to insure so far as is possible the obtaining for this purpose of coal tar creosotes similar to those which have proved effective in the past. The tar acid clause cannot entirely guarantee a coal tar oil, but it will insure that at least a certain percentage of the oil must be of coal tar origin unless the producer of the oil knowingly sophisticates it with the intent to defraud.

2. WHOLE CREOSOTE OILS. The early creosotes, which retained their wood preserving effectiveness for so many years, were whole oils. It may not yet be susceptible of proof to what extent the removal of naphthalene and anthracene derivatives, as is now common in foreign oils, or of tar acids for the phenol group of synthetic drugs, which has more recently taken place, will impair the wood preservative value of creosote. The same considerations with respect to lack of present knowledge which have just been stated have seemed to the Committee to make wise the specification of an oil which shall contain as many as possible of the constituents of an original distillate in sufficient amount to make it representative of a whole oil, as far as it is possible to do so without unduly restricting sources of oil supply or increasing the price. This consideration has partly influenced the restoration of the naphthalene clause formerly common in creosote specifications. With respect to this, however, certain special considerations will be stated later.

3. HIGH RESIDUE CONTENT. The tendency of recent years to increase the distillation temperature limits in the production of creosote oil may doubtless have produced beneficial results, within limits. Oils have recently been received on the Pacific Coast, however, in which analysis shows the proportion of residue above 355° C. to be in excess of 50 per cent. In one authentic case it reached 59 per cent. Practical experience in the conduct of the treating process seems to indicate that with so refractory a wood as Douglas fir, an oil having such an excessive residue increases the difficulty of securing penetration and the danger of insufficient penetration. Such an oil would be accepted by the standard specification of the Association. It is believed, therefore, that the amount of residue should be restricted, at least until its value or lack of value shall

have been demonstrated either by service tests or by scientific investigation.

The modifications herein presented respecting tar acids and the limiting of residue, together with certain distillation limits then believed desirable, were referred to the Preservatives Committee of the Association on July 29, 1921, and were approved by them for this purpose. Certain further modifications have since appeared to be desirable and are incorporated herein, as suggestions, from the trial of which the ultimately desirable specification may be approached. The data on which to base modification is in some cases manifestly meagre, but it is hoped that experience with this tentative specification for local application may contribute to the ultimate solution of the problem for all concerned.

TENTATIVE SPECIFICATION COVERING CREOSOTED DOUGLAS FIR PILING AND LUMBER FOR USE IN MARINE STRUCTURES

(Adopted by the Committee October, 1921.)

Material to be Treated

Piling, Green and Water Stored

QUALITY: Piles shall be cut from sound trees; shall be close grained and solid, free from defects, such as injurious ring shakes, large and unsound or loose knots, decay or other defects which may materially impair their strength or durability.

STRAIGHTNESS: Piles shall have a uniform taper and none with a swell or twisted butts will be accepted. Piling must be so straight that a straight line drawn from butt to tip will not deviate more than one (1) inch for each ten (10) feet in length; that is to say—a pile seventy (70) feet in length may deviate seven (7) inches from a straight line drawn from butt to tip. Piling with short or reverse bends, or kinks, will not be accepted.

TWISTS: No piling with spiral grain will be accepted which has one complete twist in a length of forty (40) feet or less.

TRIMMING: Piling shall have all bark and inner skin removed. Knots must be cut flush, butts and tips trimmed squarely before treatment, and in case piling has been stored in sea water, barnacles or other similar forms of sea life must be removed. Piling showing any attack by insects or marine borers will not be accepted.

SAPWOOD REQUIREMENTS: Only such piling will be accepted for treatment as conforms with the following minimum sapwood requirements:—

1. For a specified absorption ranging from twelve (12) pounds to fourteen (14) pounds of creosote oil per cubic foot of timber, the sapwood must not be at any point less than one (1) inch in depth.
2. For a specified absorption of sixteen (16) pounds of creosote oil per cubic foot of timber, the sapwood must not be at any point less than one and one quarter (1¼) inches in depth.

Except that

3. Piling which does not meet the sapwood requirements specified above will be accepted when treated separately, provided that the creosoting company will in each case guarantee the minimum penetration of creosote oil specified.

SIZES: Shall be as specified by the purchaser. For information, the following appropriate size combinations of length and butt and tip diameters are listed by groups, of which the group to be selected will depend upon the class of structure desired and the load for which it is designed:—

GROUP A

Lengths Feet	Min. Diameter of Butts Inches	Min. Diameter of Tips Inches
Up to 49 inclusive	12	8
50 to 64 "	13	8
65 to 74 "	14	8
75 to 100 "	16	8
101 and up	16	7

GROUP B

Lengths Feet	Min. Diameter of Butts Inches	Min. Diameter of Tips Inches
Up to 60 inclusive	14	9
61 to 80 "	15	8
81 to 100 "	16	8
101 and up	17	7

No piling with butt diameters greater than twenty-two (22) inches will be accepted unless otherwise stipulated.

In determining the diameter of a pile not having a circular cross section, the average of the minimum and maximum measurements at that cross section shall be taken.

Air Seasoned Piling

Piling stored on land and air seasoned must in all particulars meet the foregoing specification for green, freshly cut and water stored piling. Piling stored on land for air seasoning must be piled on bearing pieces so as to keep the piling at least ten (10) inches above the ground line and each layer of piling shall be separated from the other by strips not less than two (2) inches in thickness so as to permit a free circulation of air. Piling stored in this manner will be considered thoroughly air seasoned when the moisture content of the piling, when based on the oven dry weight, has been reduced to twenty (20) per cent.

Air seasoned piling with checks of such size as will impair the strength and durability of the piling, regardless of the fact that such checking has taken place naturally, will not be accepted.

Sawed Lumber and Timber

QUALITY OR GRADE: Purchaser to specify commercial grade desired, which shall conform to Grading Rules, standard or currently recognized in the production and marketing of the species of timber or lumber involved and to so grade after treatment.

The standard commercial grade usually specified for creosoting purposes is that known as No. 1 Common Douglas fir in accordance with Domestic List 7, edition of 1917, published by the Pacific Lumber Inspection Bureau, Inc.

Preparation for Treatment

Selecting Material for Loading Cylinder Charges

SAWED LUMBER AND TIMBER: Care must be taken to secure material of approximately the same moisture content for each cylinder charge; that is to say, green or freshly cut lumber and timber must not be mixed with seasoned or partially seasoned material.

PILING: As in the case of sawed lumber and timber all piling to be treated in the same cylinder charge must be approximately the same moisture content. In loading piling into cylinder charges the following classifications shall govern:

1. Green or freshly cut piling must be treated by itself.
2. Piling water stored for thirty (30) days or more must be treated by itself.
3. Piling partially air seasoned must be treated by itself.
4. Thoroughly air seasoned piling must be treated by itself.

Any further separation or segregation of material shall be optional with the creosoting company.

Inspection of Material Before Treatment

Before the material is loaded into tram cars for treatment, the inspector shall be given full opportunity to examine it and to check the cubature records of the plant for each cylinder charge, and these records must be open for his inspection at all times.

Thermometers and Gauges

All the treating cylinders of the creosoting company which are used on work covered by this specification shall be provided with the following accurate reading instruments:

1. Recording thermometers.
2. Recording pressure gauges.
3. Recording vacuum gauges, or combination recording pressure and vacuum gauges.
4. Indicating mercurial thermometers as a check against the recording thermometers.
5. The creosoting company shall also provide accurate maximum reading thermometers for use by the inspector from time to time in checking the recording and indicating thermometers.

The inspector must check the recording thermometers as well as the indicating thermometers at frequent intervals. This may be done by placing a maximum reading thermometer at some place on the charge which will bring it as near as possible to the thermometer that is to be checked.

When the charge is removed from treating cylinder after treatment the maximum reading thermometers shall then be read and this reading checked against the maximum temperature recorded by the recording thermometer. Should there be a variation greater than five (5) degrees F. in the reading of the two instruments, the maximum reading thermometer being correct the recording thermometer must be adjusted.

Creosote Oil

The oil shall be a distillate of coal gas or coke-oven tar. It shall comply with the following requirements:

1. It shall not contain more than 3 per cent water.
2. It shall not contain more than 0.5 per cent of matter insoluble in benzol.
3. The specific gravity of the oil at 38° C. compared with water at 15.5° C. shall be not less than 1.045.
4. The oil shall contain from 5 to 10 per cent tar acids.
5. The oil shall contain not less than 10 per cent naphthalene.
6. The distillate, based on water-free oil, shall be within the following limits:
   Up to 210° C. not more than 5 per cent.
   Up to 235° C. not more than 25 per cent.
   Up to 315° C. not less than 45 per cent nor more than 75 per cent.
   Up to 355° C. not less than 70 per cent nor more than 90 per cent.
7. The specific gravity of the fraction between 235° C. and 315° C. shall be not less than 1.03 at 38° C. compared with water at 15.5° C.
   The specific gravity of the fraction between 315° C. and 355° C. shall be not less than 1.09 at 38° C. compared with water at 15.5° C.
8. The residue above 355° C. shall have a float-test of not more than 50 seconds at 70° C.
9. The oil shall yield not more than 2 per cent coke residue.
10. The foregoing tests shall be made in accordance with the standard methods of the American Wood-Preservers' Association, with the exception of those for tar acids and naphthalene, as specified in clauses 4 and 5, which shall be made in accordance with the methods of the American Railway Engineering Association.

Treatment and Inspection

Treatment shall be by the Boulton process (boiling under vacuum)

Green or Freshly Cut, Water Stored and Partially Air Seasoned Piling

PERIOD OF ARTIFICIAL SEASONING: After the piles are placed in the treating cylinders, they shall be immersed in creosote oil having a temperature of about 160° F. and kept covered during the entire boiling period of the process, the oil level being at least four (4) inches above the top-most pile.

After filling the treating cylinder with creosote oil as above specified connections between condenser and vapor drum on treating cylinder shall then be opened; steam shall then be admitted through the heating coils and so regulated that the temperature inside the treating cylinder is kept gradually rising as fast as the condensation will permit until a temperature of 215° F. is reached. Having reached this temperature of 215° F., at least a twenty (20) inch vacuum shall be produced and maintained in the treating cylinder, the escaping vapors being drawn into the condenser and this operation continued until such time as the amount of condensation collected in the hot well of the condenser does not exceed one-tenth (1/10) of a pound of water per cubic foot of timber in charge per hour with not less than a twenty (20) inch vacuum and a temperature inside the treating cylinder of not less than 215° F. and not more than 220° F., the latter temperature being regarded as the absolute maximum that will be allowed.

PRESSURE PERIOD: After the period of artificial seasoning has been completed, as specified in the foregoing, the temperature inside the treating cylinder shall then be allowed to drop to about 200° F. The treating cylinder shall then be filled with hot creosote oil (temperature about 170° F.,) from the operating tank; the treating cylinder being full, all vents are then closed and more oil pumped into the treating cylinder from the operating tank until the pressure gauge on the treating cylinder records a five (5) pound pressure (this to insure that the treating cylinder is full). Creosote oil from a measuring tank shall then be forced into the piling by means of a pressure pump at a pressure not to exceed one hundred and sixty (160) pounds per square inch, and this operation continued until such time as the piling has absorbed the amount of creosote oil specified by the purchaser, under such conditions as will insure its complete retention in the wood after the treating cylinder has been drained. This having been accomplished, the piling may be removed from the treating cylinder provided that the temperature within the treating cylinder has dropped below 200° F. A final vacuum will be allowed for not to exceed one (1) hour, to recover drip.

Inspection of Treated Material

PHYSICAL CONDITION: After the piling has been removed from treating cylinder and allowed to cool in the air for not less than six (6) hours, it must be free from all heat checks, water bursts, and other defects due to inferior treatment which would, in the opinion of the inspector, impair its usefulness or durability for the purpose intended.

ABSORPTION: Shall be as specified by the purchaser.

PENETRATION: Piling shall be accepted upon the showing of penetration of creosote oil in each pile. This penetration must be based on black or very dark oil and in no case will a light discoloration of the wood due to treatment be taken into consideration in measuring the depth of penetration upon which the piling is to be accepted. The test for penetration shall be made by boring the piling midway between ends with either an increment borer, or a five-eighths (⅝) inch auger, the choide of which shall be optional with the inspector. All holes so bored shall be plugged with a tight-fitting creosoted plug furnished by the creosoting company. Should the inspector, upon boring the piling, find that the borings contain free moisture, he shall reject any such piling and have same retreated under the conditions hereinbefore specified. The inspector must in all cases bore every pile in the charge for penetration and at least six (6) of these piles must be bored from two different angles in order that he may satisfy himself that the piling have the minimum penetration specified on all sides.

The minimum depth of penetration with a specified amount of creosote oil shall be as follows:

12 pounds of oil per cubic foot	¾ inch
14 " " " " " "	1 "
16 " " " " " "	1-¼ "

The curves shown on diagram 1 are given for information and show the theoretical relationship between the amount of creosote oil injected per cubic foot and the average depth of penetration in inches.

Air Seasoned Piling

In the treatment of air seasoned piling, where artificial seasoning is unnecessary, the piling shall be held in the hot oil, under same conditions as specified for green and water stored piling, until such time as it has been heated sufficiently to enable impregnation without the use of excessive pressures. This having been accomplished the specified amount of creosote oil may then be injected as in the foregoing case of green or water stored piling, and upon being removed from treating cylinder, under similar conditions, shall stand the same detailed inspection.

When air seasoned piling is found to be case hardened, preliminary steaming will be allowed for a period not exceeding four (4) hours at pressure not to exceed twenty (20) pounds.

Green or Freshly Sawed Lumber and Timber

As hereinbefore specified, this material must be treated separately and must not, under any circumstances, be loaded with partially seasoned or thoroughly air seasoned material for the same cylinder charge. In loading sawed lumber and timber into cylinder tram cars for treatment, separators must be placed between all tiers as the material is placed on the tram car in order to insure complete access of the creosote oil to all surfaces of the wood.

The process of treatment shall be identical with that specified for green or water stored piling with the exception that the minimum and absolute maximum temperatures allowed will be 180° and 190° F., respectively; and this temperature shall be maintained constantly under at least a twenty (20) inch vacuum throughout the entire period of artificial seasoning until such time as the water accumulating in the hot well of the condenser is not in excess of one-tenth (1/10) of a pound of water per cubic foot of timber in charge per hour.

Air Seasoned Sawed Lumber and Timber

This material, as in the case of green or freshly sawed lumber and timber, shall be treated separately and in no case shall it be mixed and treated together in the same cylinder charge with other material of varying moisture content.

In this case, the period of artificial seasoning may be dispensed with, but the material must be held in the hot oil, under the same temperature limits outlined for green lumber and timber until it is heated sufficiently to permit proper treatment. This having been accomplished pressure may be applied until the specified absorption has been reached.

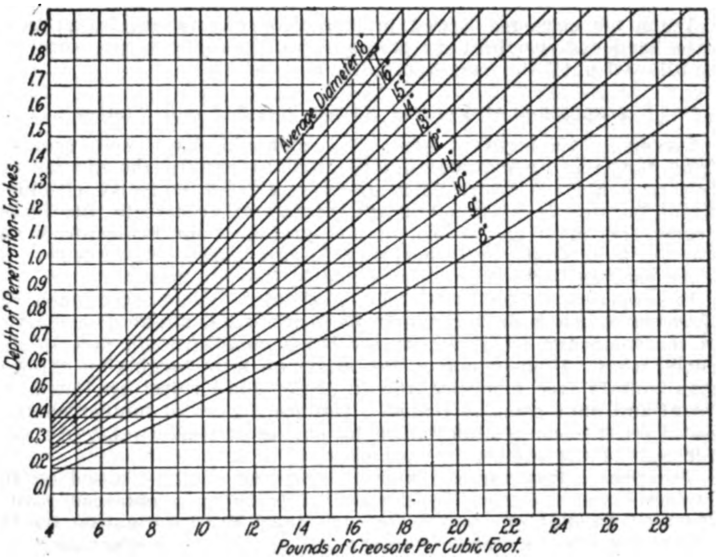

Diagram 1. Penetration of Creosote in Round Piling.

Compiled by R. H. Rawson, 1916

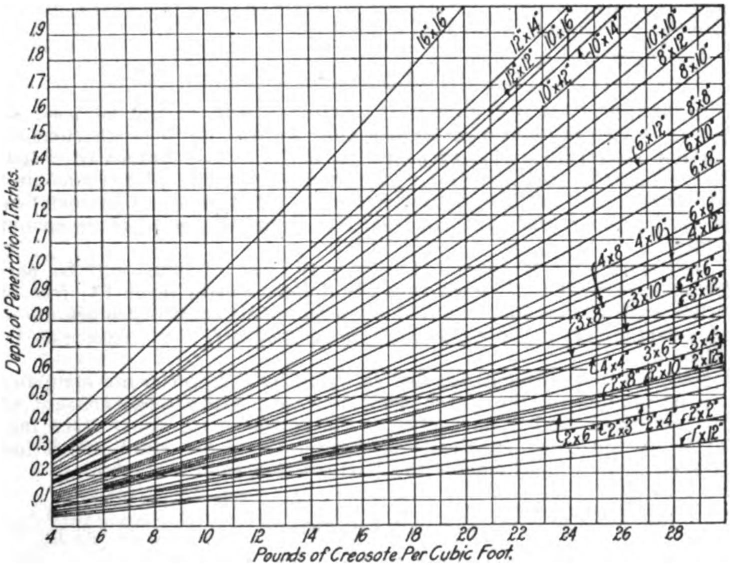

Diagram 2. Penetration of Creosote in Various Sizes of Sawed Lumber and Timber.

Compiled by R. H. Rawson, 1916

When air seasoned sawed lumber and timbers are found to be case hardened, preliminary steaming at atmospheric pressure will be allowed until the case hardening is relieved.

Inspection of Treated Sawed Lumber and Timber

PHYSICAL CONDITION: After the material has been removed from the treating cylinder and allowed to cool in the air for not less than six (6) hours, it must be free from excessive checking, water bursts, warping, shrinkage, or any other defects due to improper treatment and which, in the opinion of the inspector, would impair its strength and durability for the purpose intended.

ABSORPTION: Shall be as specified by the purchaser.

PENETRATION: The treated material shall be accepted upon the showing of black or very dark oil penetration, slight discoloration of the wood due to treatment not being considered in determining penetration. If upon boring the material, it is found that the borings contain free moisture, the inspector shall reject any such material and have same retreated. The acceptance of lumber shall be based on the penetration shown by boring at least twenty-five (25) per cent of the lumber in each charge.

The penetration for any given absorption shall be based on the surface area exposed. The theoretical depth to be obtained with a specified amount of creosote oil, is shown for information on the curves for various sizes of lumber and timber. See diagram 2.

Condition of Materials

No treated piling, lumber or timber will be accepted that has been injured during treatment by rubbing or scraping against tram arms or rivet heads or by rough handling.

Handling of Creosoted Material

In handling creosoted material extreme care should be used so as not to damage edges of lumber and timbers, or to break through portion penetrated with creosote oil or to expose untreated wood. Sharp pointed tools, such as cant hooks, peavies, pickaroons and crowbars, must not be used except in the ends of sawed material or in the ends or within three (3) feet from the ends of creosoted piling.

In the rafting of creosoted piling, the use of dogs will be permitted, provided that these dogs are driven within three (3) feet of either end of the pile. Should the creosoting company place these dogs farther from the ends than above specified, the piling may be rejected.

No creosoted material carried in stock by the creosoting company can be applied on the purchaser's contract, without the consent of the purchaser, and if agreeable to the purchaser to apply stock material on his contract, this must stand the same rigid inspection as hereinbefore specified for the various classes of material.

General Conditions

1. The creosoting company shall furnish an affidavit giving a description of the material furnished—if lumber, the grade, treatment

and tally of same; if piling, the butt and tip measurements, lengths, and treatment; and in all cases an analysis of the creosote oil with which the material was treated.

When material is purchased subject to tally and inspection of the creosoting plant, such inspection at the plant as evidenced by the sworn certificate, shall be final.

2. An inspector may be appointed by the purchaser to make such inspection at the creosoting plant as will enable him to accept such material, before and after treatment, as meets the requirements of this specification.

3. All facilities and reasonable assistance which the inspector may need to execute his work shall be given by the creosoting company free of cost to the purchaser.

4. The creosoting company shall supply the inspector from time to time with such samples of creosote oil which is being used or is to be used in the creosoting of material for the purchaser, and at such intervals as the inspector may direct; these samples to be taken from the treating cylinder, measuring tank, operating or storage tank, at the option of the inspector. The samples of creosote oil thus taken are to be sent to the purchaser for analysis, unless the inspector be qualified by both training and experience to make these analyses, and the purchaser authorizes him in writing to conduct such analyses at the plant. In this case the creosoting company shall provide him with the necesary chemicals and laboratory equipment for carrying on this phase of the inspection.

5. The fact that the purchaser has an inspector at the plant will not relieve the creosoting company of the responsibility of seeing that the treatment of all material is properly done, with the agreed penetration of oil secured in each case as specified by the contract absorption.

6. The inspector shall have access to all parts of the plant which have to do with the treatment of material under his charge.

Notes on Creosote Oil Specification

The detailed modifications of the standard specification of this Association for ties and structural timbers which are involved in the tentative specification above given are embraced in the following clauses:

> Clause 3. The specific gravity of the oil at 38° C. compared with water at 15.5° C. shall not be less than 1.045.
>
> Clause 4. The oil shall contain from 5 to 10 per cent tar acids.
>
> Clause 5. The oil shall contain not less than 10 per cent naphthalene.
>
> Clause 6 (new distillation limits). Up to 315° C. not less than 45 per cent or more than 75 per cent. Up to 355° C. not less than 70 per cent or more than 90 per cent.
>
> Clause 7 (second paragraph). The specific gravity of the fraction between 315° C. and 355° C. shall be not less than 1.09 at 38° C. compared with water at 15.5° C.

Clause 3. This clause is largely dependent upon clauses 6 and 7 and will be discussed in connection with them.

Clause 4. Records are available in San Francisco to show that 20 years ago the average tar acid content of creosote oils was in the neighborhood of 8 or 9 per cent. In the analyses of Long Wharf piling the tar acid content of the extracted oils averaged nearly 4 per cent, and was doubtless higher than that in the original oils before treatment.

Clause 5. The requirement of a moderate naphthalene content is again based upon the conservative position with respect to the incompleteness of present knowledge, that it is desirable to require in the oil those constituents which were present in considerable amount in the whole oils which in past years have proved effective; of which naphthalene is one. The minimum limit of 10 per cent for naphthalene has been selected after careful study of the analyses of a large number of oils. It is possible to meet this requirement with any average grade of whole oil.

The probable value of naphthalene in an oil for the preservation of marine piling is increased by the observed fact that the rate of loss of naphthalene from treated wood submerged in water is very slow, in contrast to its rapid loss from treated wood exposed in air. Whatever value the naphtalene has will therefore be longer effective in marine work than in land work.

Clause 6. The analyses of a large number of oils used in the past show that at least 50 per cent distilled below 315° C., and that the residue above 355° C. rarely exceeded 30 per cent. This has determined the minimum limits of 45 per cent for the amount distilling below 315° C. and 70 per cent for the amount distilling below 356° C. The maximum limit of 90 per cent for the latter rests upon the conclusion, as a result of our work, that some residue above 355° C. is desirable to give stability to the oil, by minimizing leaching.

Clause 7 (second paragraph). There seems to be substantial agreement in the industry that the specific gravity limit of 1.10 set, in the standard specification, for the fraction between 315° C. and 355° C. is too high. It has often failed of fulfilment in practice. The limit of 1.09 herein specified has been selected after careful study of a large number of oils, as permitting the use of the widest practicable number of otherwise satisfactory oils, both domestic and foreign.

Clause 8. The specific gravity of the whole oil is largely determined by the requirements made for the several fractions. The distillation percentages required for the fractions in Clause 6 and the specific gravities required for them in Clause 7 necessitate for the whole oil a specific gravity of approximately 1.045, as specified.

The large number of records examined by the Committee do not indicate that any large percentage of oils will be barred by this specific gravity. The aim of the Committee has been to assure the users of creosoted material for marine structures against defective oils, while on the other hand to leave the field as open as possible to the producers of creosote oil.

BIOLOGICAL SECTION

By Charles A. Kofoid and Robert C. Miller

The biological report for the present year is restricted to *Teredo navalis*, including a brief statement of its action in San Francisco Bay during 1921, a preliminary discussion of the factors limiting the persistence and distribution of this borer in the bay with reference to salinities, some notes on the breeding season and a statement regarding its specific identity. For locations mentioned herein see map accompanying last year's report.

The data and graphs of salinities utilized in this discussion were prepared under the direction of the Subcommittee on Salinities, Carlos E. Cortes, Chairman. The analyses at Crockett were made in the laboratory of the California and Hawaiian Sugar Refining Company; at Martinez in the laboratory of the Shell Oil Company; at Avon in the laboratory of the Associated Oil Company; at Bull's Head Point in the laboratory of the Mountain Copper Company; at Port Costa, Black Point, Greenbrae and Tiburon in the laboratory of the Wood Preserving Plant of the Southern Pacific Company.

Action of Teredo in San Francisco Bay in 1921

The destructive action of *Teredo* in San Francisco Bay in 1921 has continued in unprotected timbers wherever available, as is shown by the infection of experimental timbers in the Bay proper, and in Carquinez Strait as far up as Rowe Island Light, opposite Bay Point, eleven miles above the lower entrance to the Strait and well into Suisun Bay.

Since there is far less unprotected piling accessible to the borer this year than in the previous years, the infection and the number of larvae available for new settlement are both reduced. Their action in favorable localities, as for example in Carquinez Strait, has been typically destructive. New untreated piling driven in April, 1921, in 36 feet of water at Crockett were attacked so heavily, especially near the mud line, as to be broken off in December. The first settlement of larvae at Crockett was detected on the test timbers on August 8. Penetration of piling to a depth of 1¾ inches was attained by November 8 and specimens 4 inches in length were found in test timbers on that date.

In 1920, piles driven at Crockett in January were attacked by *Teredo* at some time in the spring and were penetrated to a depth of two inches by May. This indicated conclusively the settlement of larvae within that period. The interpretation was then made that these were larvae of the year and not holdovers from 1919. However, in 1921 no settlement of larvae at any point in the Bay, from Dumbarton to Martinez, was detected until July 20, as shown below on test timbers examined at monthly intervals.

LOCATION OF TEST TIMBER	FIRST DATE OF SETTLEMENT	MEAN SALINITY FOR 5 DAYS PRECEDING, PARTS PER 1000.
Dumbarton	July 20	
Goat Island	Aug. 15	
Oakland Harbor Light	Aug. 15	
Black Point	Sept. 15	24.3
Mare Island Strait	Aug. 26	
Crockett	Aug. 8	21.1
Port Costa	Aug. 23	20.3
Benicia	Sept. 22	
Martinez	Nov. 15	17.9
Rowe Island	Nov. 15	

It appears from these records that the breeding season of *Teredo* began several months later in 1921 than in 1920, or that larvae of 1919 survived to a later date in 1919–20 than in 1920–21. Data are lacking to determine with certainty which of the two conditions prevailed. The lower salinities of the winter of 1920–21 might explain the delay in Carquinez Strait, but not elsewhere in the Bay region. It is possible that temperatures might explain this contrast, but unfortunately we have complete records only of air temperatures, not of those of the Bay waters. The spring season of 1921 was delayed and vegetation showed the depressing effect of the prolonged lower temperatures.

Factors Limiting the Persistence and Distribution of Teredo navalis in San Francisco Bay in 1921

The adequate determination of the environmental conditions which limit the persistence and inhibit the extension of *Teredo navalis* in San Francisco Bay will require much more investigation than has been thus far accomplished. Certain facts bearing on these problems are here presented as a progress report, since they may be of value in the consideration of preventive measures here and elsewhere.

Two distinct phases of these problems suggested themselves for investigation in our locality. The first is the relationship of salinity to the survival of *Teredo* in Carquinez Strait, where summer salinities are high, permitting the rapid growth and even more startling invasion of this pest, and where salinities during the winter months are greatly reduced. This problem is complicated by the fact that the period of low salinity coincides with that of the seemingly normal annual dying-off of many individuals here and elsewhere, and is still further complicated by other environmental factors, such as changing food supply and disease. The lowered salinity is therefore only one of several factors operating to reduce and destroy *Teredo* in Carquinez Strait in the winter months.

Examinations of piling at several localities along Carquinez Strait from January to April, 1921, have shown no living *Teredo* above Crockett. These borers were apparently all dead at localities above Crockett by about the middle of February, whereas in the preceding November they are extended up stream for twenty-two miles to Antioch with the invasion of sea water. By midwinter they were apparently exterminated, not only in the region of Suisun Bay, including its lower end near Martinez, where the influence of the fresh water run-off dominates, but also well down the narrower Carquinez Strait where tidal flow from San Pablo Bay brings periodically, at spring and midtides, considerably increased contributions of sea-water. There was, however, a sufficient amount of sea-water at Crockett, and at the Carquinez Strait Light on the opposite side of the Strait, to permit a small number of *Teredo* to survive at this point, which is thus established as the winter or flood survival barrier in 1921.

At the Carquinez Strait Light Station, on April 25, 1921, a living *Teredo* was found in a pile in shallow water near low tide level, which was doubtless a survivor from the previous autumn. As only one pile was pulled for examination here, it seems extremely probable that this solitary specimen was a representative of others which had lived through the winter in neighboring piles. In the Mare Island dyke, near the Carquinez Light, which is more directly exposed to the influx of fresh water from Napa Creek, all *Teredo* were found to be killed off and a subsequent inspection of a number of piles pulled for the Committee at various points along the Mare Island Channel failed to show any living specimens.

At Crockett, on June 10 and 11, numerous healthy *Teredo* were found in two piles pulled at different points along the waterfront of the California and Hawaiian Sugar Refinery. These specimens averaged rather more than 4 inches in length and must certainly have represented an infection of the previous autumn, as test-timbers planted here in March had up to that date showed no infection. No evidence of breeding activity, as shown by larvae in parent adults and by attacks of young *Teredo* on test timbers, were detected anywhere in the Bay until some time later than this. It should be mentioned that nine other piles pulled at Crockett at this time contained only the shells and occasional pallets of specimens some time dead, indicating that only a small minority of the many *Teredo* present in November had survived the lowered salinities prevailing in this region during the winter months. The living *Teredo* at Crockett were all found within six feet of the mud line in twenty feet of water.

Above Crockett, as has been indicated, no living *Teredo* were found, although field work was carried on as far up as Avon. In the upper Strait and in Suisan Bay the water evidently becomes sufficiently fresh during the rainy season to prove lethal to the borers, as it does to most other marine life.

In the lower bay living *Teredo* may be found at any season of the year. Investigations in the spring and early summer, however, showed many of the burrows to be empty, thus supporting the conclusion that the annual autumnal or winter death rate is extremely high, only a limited number surviving to propagate at the opening of the next breeding season.

The environmental conditions destructive to *Teredo* are therefore to be sought above Crockett, or in the surface waters in the Strait near Crockett itself. The following tables and the salinity graphs (plates 15 and 16) present the available data from the records of salinities at Crockett, Port Costa (one mile above), Martinez (five miles above), and at several other points which are of significance in the destruction of *Teredo*. It is well known that *Teredo* survives in its burrows for some days both in fresh water and out of water. In the Committee's laboratory normal *Teredo* in their burrows placed in running fresh water in November and December were all killed off within nine days, most of the deaths occurring on the eighth and ninth days, at 50°–65° F. Controls in standing and running salt water survived. In Carquinez Strait, *Teredo* in piling are subject for varying periods to water of varying degrees of salinity. This is due mainly to the interaction between tides entering from San Pablo Bay, and run-off from the rivers entering Suisun Bay above Martinez. At each recurrent flood tide more highly saline water enters from San Pablo Bay along the bottom and at the ebb the fresher water pushes down the straits from Suisun Bay on the surface. The average difference between the salinities at high tide at surface and bottom at Port Costa for January, February, March and April, 1921, was 2.9, 2.7, 3.7 and 4.0 parts per 1000, respectively, while the minimum and maximum differences between surface and bottom on any one daily tide were 0.2 and 6.0, 0.3 and 6.4, 0.0 and 9.0, and 0.6 and 9.1, respectively. *Teredo* near the mud line have a better chance of survival than those nearer the surface, since the salinities are higher there than at the surface.

The borers are able to protect themselves for a certain period of time against the invasion of much fresh water by closing the orifice of the burrow with their pallets and thus retaining the salt water in their burrows. In time their respiratory needs compel a resumption of the circulation through their siphons. The repetition of this process in time dilutes the salt water and the animal becomes relaxed, no longer withdrawing the siphons when irritated, and soon dies.

The sense organs at the tips of the siphons apprise the animal of the relative salinity of the water at the orifice. With each returning flood tide and increased salinity the circulation of water through the siphons is resumed, provided the salinity is high enough or the respiratory need great enough to stimulate its resumption.

The lethal action upon *Teredo* of brackish or fresh water is thus a function of two variables, the salinity (or lack of it) and the length of time between recurring periods of higher salinities which permit resumption of more normal functioning. A *Teredo* might be able to survive completely in repeated exposure to fresh water, provided sea water of sufficient saline content was available between times. A separation of the relative action of these two factors can be made only by carefully controlled experiments. Both factors operate continuously in Carquinez Strait owing to tidal changes.

It is obvious from the above consideration that mean salinities do not fully reveal the lethal factors or their operation. These are best revealed by the minimum salinities on the one hand and on the other by the length of the intervals between recurring spring and midtides of the month or other fluctuations which permit a sufficient restoration of normal respiration and feeding to continue the life of the borer. The survival of *Teredo* for 9 days in fresh water suggests an approximate adaptation to survival from the spring to the midtide and vice versa. From the records of the Dutch investigators of pile worms it has appeared that a minimum salinity of 9 parts of salt per 1000 permits the occurrence of *Teredo*. Our records indicate that *Teredo* survived here in the winter of 1920-21 in salinities which were much lower than this, at least for much of the time from December to April. The mean salinity at Crockett at the surface at low tide from November 19, 1920, to April 30, 1921, was 2.76. At high tide it was probably 2.5 to 5 parts higher. *Teredo* survived near the surface in approximately these conditions at Carquinez Strait Light, one mile below Crockett and at the bottom, up to within 14 feet of the surface, at Crockett itself.

We have available this year records of salinities at surface and bottom at high and low tides, at Port Costa three times per week, and daily at Martinez, but records only at the surface at low tide daily at Crockett.

These salinities are analyzed in the accompanying tables, with reference to the total number of days, from November 19, 1920, to April 30, 1921, the flood period of lowest salinities above and below each of the parts per 1000 of salt from 1 to 15, at the bottom at high tide at Port Costa, 2.5 miles above Crockett, and at Martinez, 5 miles above. Bottom waters at high tide exhibit the maximum available salinities most favorable to *Teredo*. The number of days of recurrent periods of salinity at or above each of the parts per 1000, and the average and the maximum days of lower salinities, between these periods, are also tabulated. The number of periods and total number of days of given salinities (or above) represent opportunities for more normal respiration and feeding. The number of days below represent less favorable periods, periods of more or less suspended activities or of deteriorating influences, while *the most critical factor of all is the maximum number of days between periods of given salinities, especially the lower ones.* It is during these intervals of low salinities that the more saline contents of the water in the wood and in the burrow and the mantle cavity of the *Teredo* are being gradually or intermittently diluted.

This table shows that at both Port Costa and Martinez at the bottom at high tide, that is, under most favorable conditions, for the period of low salinities of 163 days from November 19 to April 30, the salinity was at the lowest level (below 1 part per 1000) for 33 and 17 days at Martinez and Port Costa, respectively, with an average of 3 and 3.4 days between recurrent higher salinities, and a maximum stretch of 15 and 12 days, respectively. These results approximate those of the laboratory tests. The number of days at or below a given salinity and the average and maximum length of periods of tension between recurrent higher salinities steadily increase as the parts per 1000 increase. In other words, at the mud line and all points above, at Port Costa and Martinez, from November 19 to April 30 *Teredo* was repeatedly exposed to a tension of salinities which were lowered beyond the experimentally determined breaking point, that is, for more than nine days. Exposures to higher salinities were insufficient in saline content and too far apart, at least in one instance, within this period, to permit *Teredo* to survive.

The survival of *Teredo* in minimal amount near the surface at the Carquinez Strait Light about one mile below Crockett is indicative that salinities at that level represent approximately the survivial level of these environmental conditions for this species of borer in an area of changing tidal waters. The graphs of salinities of samples taken at low tide at Crockett from four feet below the surface are shown in plate 16, and are analyzed in the accompanying table.

CONDITIONS OF RESPIRATION AND FEEDING FOR TEREDO AT PORT COSTA AND MARTINEZ, NOV. 19, 1920 TO APRIL 30, 1921.

Salinities at high tide, bottom

Parts per 1000	No. of periods	Days at or above	Days below	Average days between periods	Greatest No. days between periods
			Port Costa		
15	2	4	159	79.5	162
14	3	5	158	52.7	103
13	3	7	156	52.0	103
12	4	12	151	37.8	102
11	4	17	146	36.5	102
10	7	28	135	19.3	64
9	9	37	126	14.0	27
8	9	49	114	12.7	26
7	11	77	86	7.8	24
6	9	101	62	6.9	24
5	9	112	51	5.5	21
4	8	130	33	4.1	19
3	7	139	24	3.4	15
2	6	143	20	3.3	14
1	5	146	17	3.4	12
			Martinez		
15	2	5	158	79.0	162
14	2	5	158	79.0	102
13	4	7	156	39.0	86
12	4	7	156	39.0	86
11	5	10	153	30.6	85
10	6	11	152	25.3	83
9	9	13	150	16.7	45
8	14	24	139	9.9	30
7	18	36	127	7.0	27
6	18	44	119	6.6	27
5	16	64	99	6.2	27
4	20	80	83	4.1	26
3	16	95	68	4.2	19
2	13	115	48	3.7	16
1	11	130	33	3.0	15

The salinity in Carquinez Strait increases from Suisun to San Pablo Bays which it connects. As shown in the graphs of last year's report (plate 36), it is generally about two and sometimes five parts per thousand higher at the upper than at the lower end. Crockett lies near the lower end, about one mile above Vallejo Junction and the Carquinez Strait Light on the opposite side. The increase in salinity at comparable tides between Carquinez Strait Light over that at Crockett is therefore small, probably less than 1 part per 1000. For practical purposes salinities at Crockett at the surface present approximately the survival level.

The following table analyzes the salinities at low tide, or the period of maximum freshness of the water, at Crockett. Unfortunately we have no records at high tides, when *Teredo* might be expected to avail itself of water of higher saline content for respiration and feeding. An additional complication is introduced by the fact that the days of minimum salinity at low tide which occur at the spring tides are also those of maximum salinity at high tide.

CONDITIONS OF RESPIRATION AND FEEDING FOR TEREDO AT CROCKETT, NOV. 19, 1920 TO APRIL 30, 1921.

Salinities at low tide, surface.

Parts per 1000	No. of periods	Days at or above	Days below	Average days between periods	Greatest No. days between periods
15					
14	1	1	162		
13	1	1	162		
12	1	2	161		
11	1	2	161		
10	2	4	159	79.5	103
9	2	5	158	79.0	102
8	3	7	156	52.0	102
7	7	12	151	21.6	71
6	10	20	143	14.3	40
5	10	26	137	13.7	27
4	14	41	122	8.7	25
3	15	55	108	7.2	18
2	17	85	78	4.6	8
1	13	109	54	4.1	5

According to the table there were at Crockett from November 19 to April 30 in surface waters, 13 periods averaging 4.1 days in length and totalling 54 days, with salinities of less than 1 part per 1000, with a maximum length of 5 days. Below 2 parts the maximum length was 8 days, below 3, 18 days. *Teredo* survived at approximately the salinities shown in the table at Carquinez Strait Light, and at Crockett near the mud line in 14 feet of water where the salinities are higher than at the surface. Since the intervals of 25 and 27 days in the table represent the interval between the monthly spring tides, it is evident that *Teredo* survived for these periods in water of a salinity at no time over about 4 or 5 parts per 1000, or adding 1 part for the distance to Carquinez Strait Light, 5 or 6 parts per 1000, while in 14 feet of water at Crockett it survived for tensions of somewhat shorter periods.

Specific Status of the Teredo of San Francisco Bay

The boring mollusk responsible for the extensive destruction of piling in San Francisco Bay in 1917-20 was identified by us in our report for 1920 as *Teredo navalis* Linnaeus, the well known pile worm of European waters. It has since been described by Bartsch* as *Teredo beachi*, new species, but without designation of the characters which differentiate it from *Teredo navalis*. We have not had specimens of *T. navalis* from the U. S. National Museum for comparison, but through the kindness of European specialists we have been able to obtain named specimens of *T. navalis* from Plymouth, England; Copenhagen, Denmark; Helder, Holland; and Naples, Italy. Comparison of the *T. navalis* from San Francisco Bay with these European specimens confirms our identification. Specimens from San Francisco Bay which we have sent to Paris have been identified by Dr. Lamy of the National Museum of Natural History at Paris as *T. navalis*. Dr. W. T. Calman, specialist for the British Committee on Marine Structures writes that our figures are undoubtedly of *T. navalis*.

The Pacific Coast has been ransacked for decades by conchologists such as Cooper, Dall, Stearns, Williamson, Hemphill, the Oldroyds, and many others, but no one found *T. navalis*. It was not met with in the Survey of San Francisco Bay by the U. S. Steamer Albatross, nor in any of the extensive collections made by the Scripps Institution of the University of California in coastal waters of California. Its behavior in Carquinez Strait in 1917-1920 and in 1921 is of such intensity that it is highly improbable that it could have been present in earlier years and have escaped notice.

It appears that there are thus sound biological grounds for regarding this *Teredo* as a new introduction from some other area of distribution. Other introduced mollusks are well known in San Francisco Bay, such for example as *Ilyanassa obsoleta* Say. Additional evidence that it is a new intruder arises from the fact that untreated piling at Port Costa driven prior to 1870 was untouched by *Teredo* prior to the recent outbreak, although several periods of low rainfall similar to the recent one have intervened, which might have permitted an outbreak.

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* Bartsch, P. A. A new classification of the shipworms and descriptions of some new wood-boring mollusks. Proc. Biol. Soc. Washington, vol. 34, pp. 35-42. March 31, 1921.

Teredo navalis lives in a wide range of salinities in San Francisco Bay and is subject, therefore, to considerable variation which does not, however, obliterate its specific identity with the European species, *T. navalis.*

The fact that this notorious pest of marine piling in European waters has established itself in San Francisco and San Diego Bays, where it repeats its history of destruction of marine piling elsewhere, is indicative of the possibility of its invasion of other regions. Hence engineers in charge of the construction and maintenance of marine structures in marine and brackish waters at present free from *Teredo navalis* should be on guard against its occurrence and provide against its destructive activities by suitable protective or preventive measures.

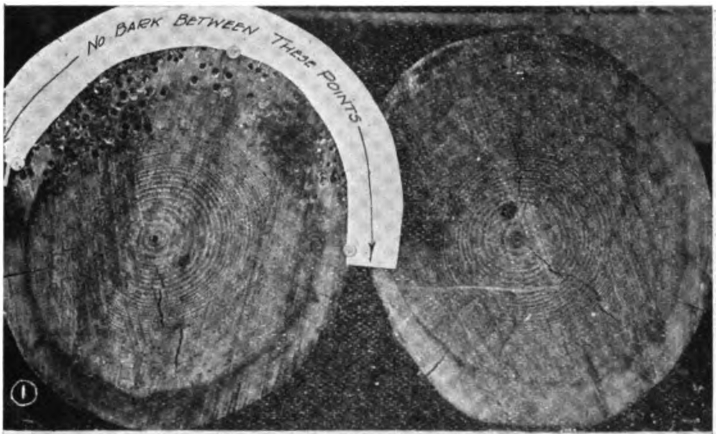
FUTURE WORK

The scope of the work now contemplated by this Committee will be sufficiently clear from the reports on the several phases of the work. No statement will therefore be repeated here. The considerations which indicate the necessity of a continuation of the work, it is believed, will also have been made clear. The Committee feels that they are of urgent weight. It therefore desires to recommend to the Association, in the strongest manner possible, the granting of its authority for such a continuance.

For the San Francisco Bay Marine Piling Committee,

C. L. HILL, *Chairman*
F. D. MATTOS
A. A. BROWN
W. C. BALL
C. A. KOFOID
L. D. JUBS
C. E. CORTES
H. H. HALL
F. G. WHITE
Executive Committee.

PLATE 1



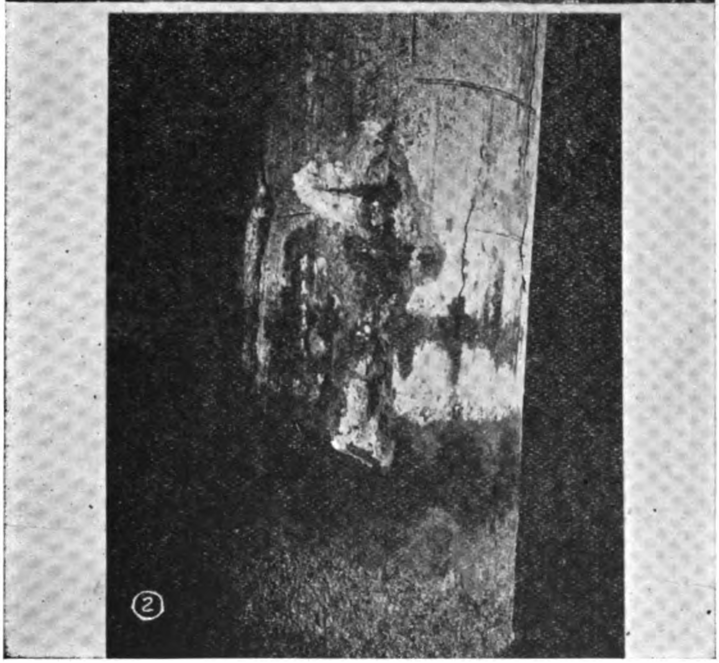
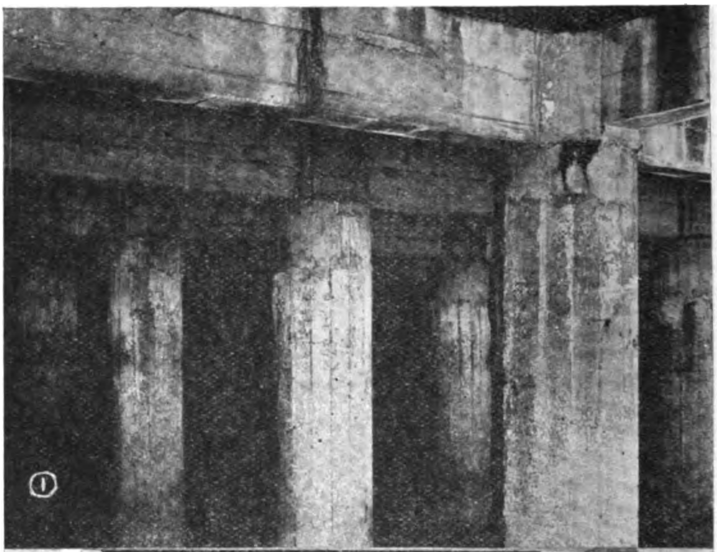


Fig. 1. Pile from Associated Oil Co. Wharf, Port Costa; driven with bark on, presumably in 1910; removed in 1921. Borers attacked where bark protection was damaged.

Fig. 2. Concrete protected pile, Koetitz type, showing typical rusting creck above high tide level. Fsom bulk head between Piers 28 and 30, San Francisro; driven 1909.

PLATE 2



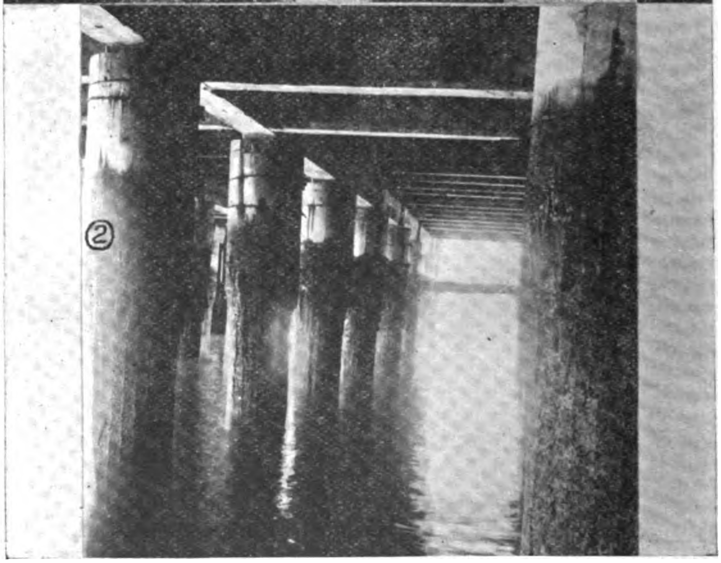
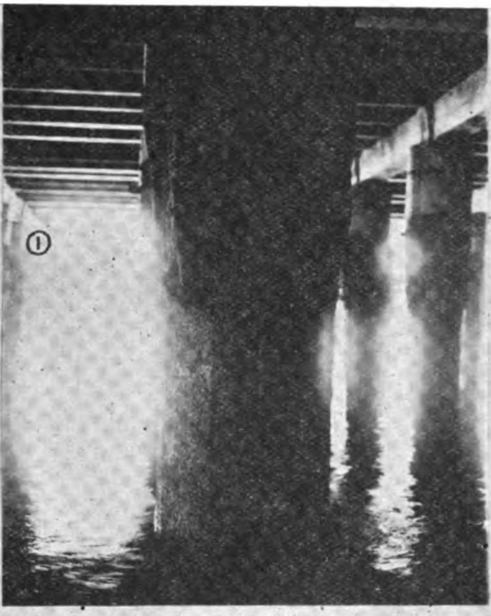


Fig. 1. Concrete protected piles, Koetitz type, Pier 17, San Francisco. 10 years exposure, good condition.

Fig. 2. Concrete protected piles, Holmes single-pile type, Pier 34, San Francisco. 11 years exposure, good condition.

PLATE 3



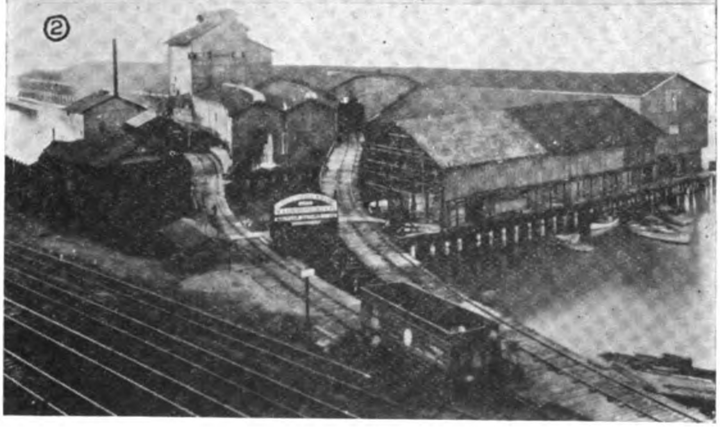
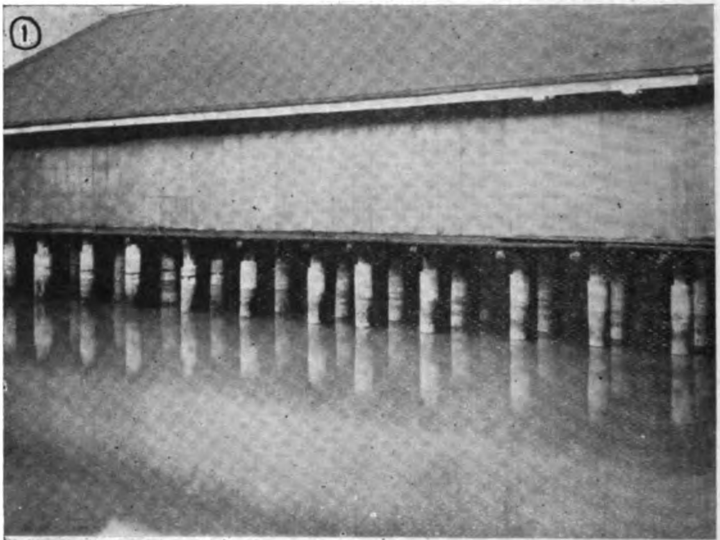


Fig. 1. Concrete protected pile, concrete casing defective due to improper tamping.

Fig. 2. California Wharf and Warehouse, Port Costa. Untreated wooden piles protected 1921 by Larsen–Camp concrete casing applied in place.

PLATE 4



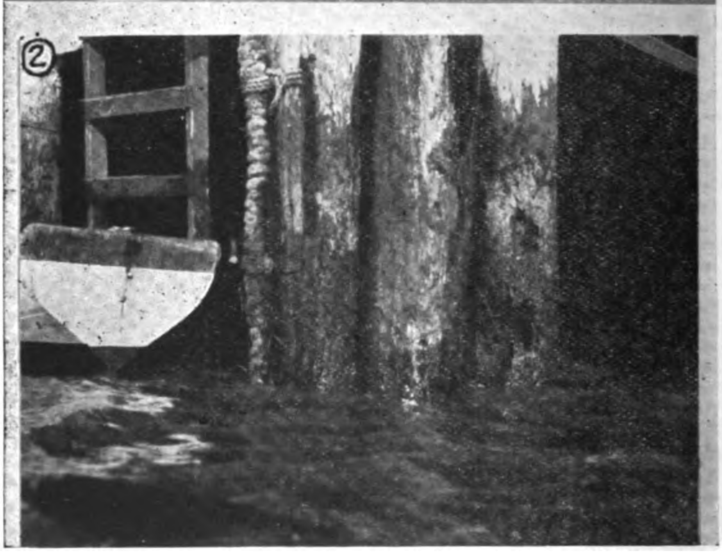
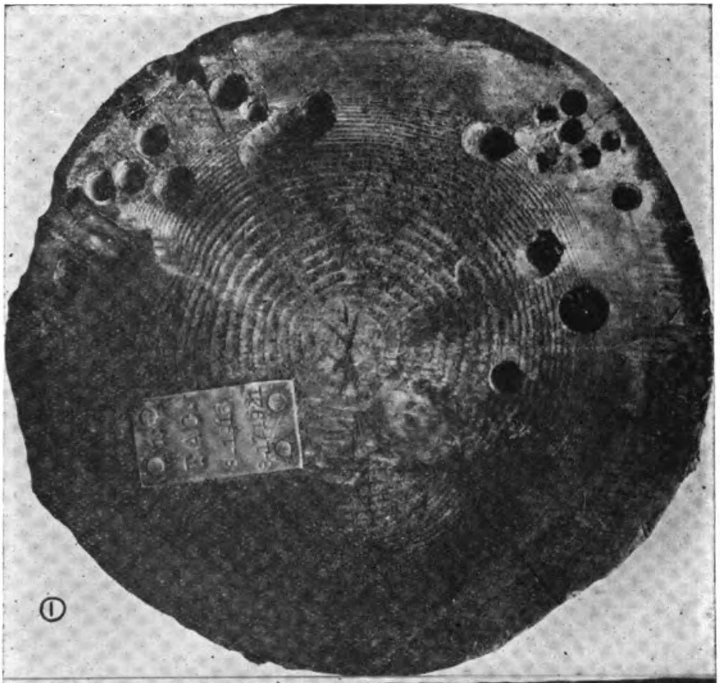


Fig. 1. Concrete protected piles, California Wharf and Warehouse; Larsen–Camp process, installed 1921.

Fig. 2. Creosoted piles, Western Pacific Ferry Slip, Alameda, attacked by *Limnoria* at bolt and dog holes.

PLATE 5



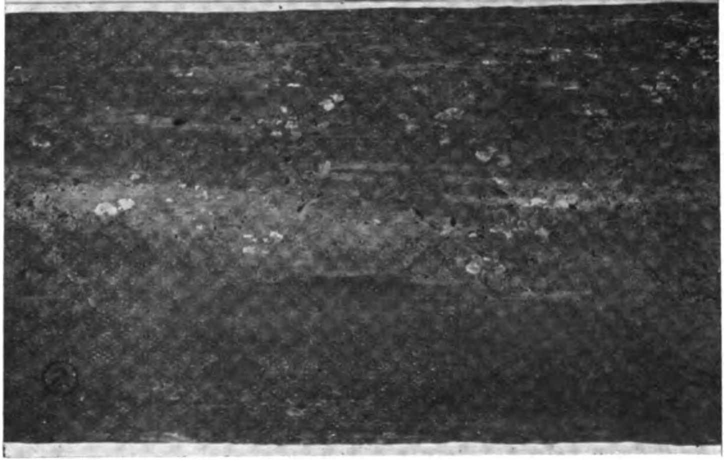
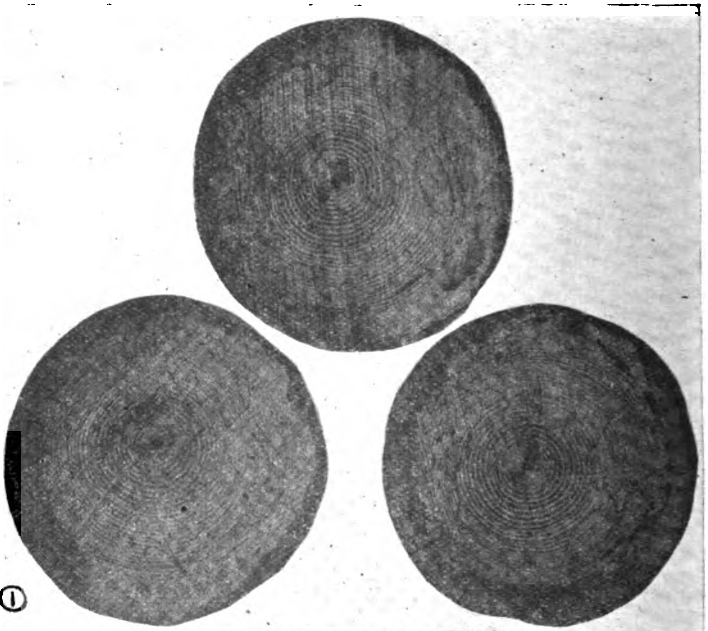


Fig. 1. Cross-section of pile, showing thin treatment through which *Xylotrya* penetrated to interior of pile.

Fig. 2. Surface of same pile as in fig. 1, showing entrance holes of *Xylotrya*.

PLATE 6



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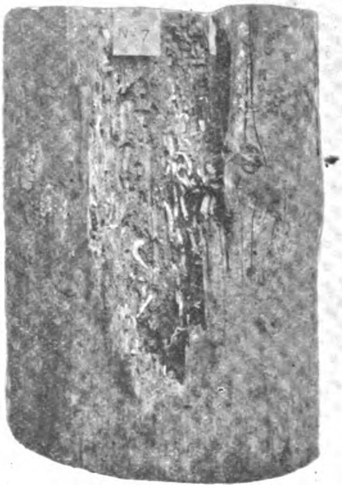
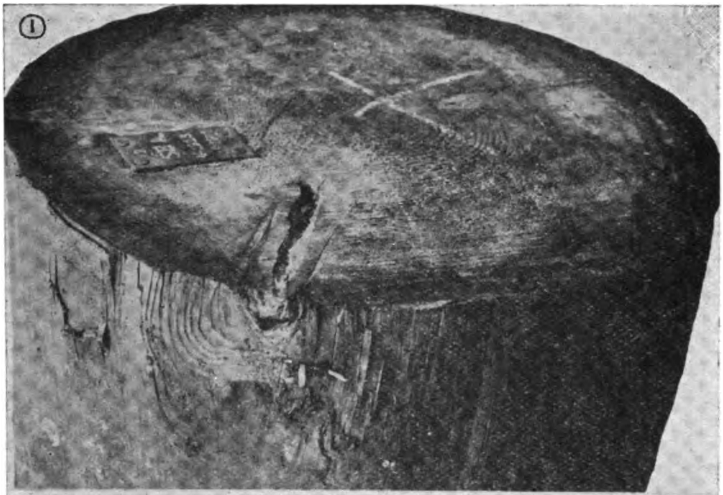


②

Fig. 1. Sections of new creosoted piles delivered on San Francisco Bay, 1921, showing uneven penetration of creosote.

Fig. 2. Attack on pile by *Limnoria* and *Xylotrya*, made possible by thin creosote penetration.

PLATE 7



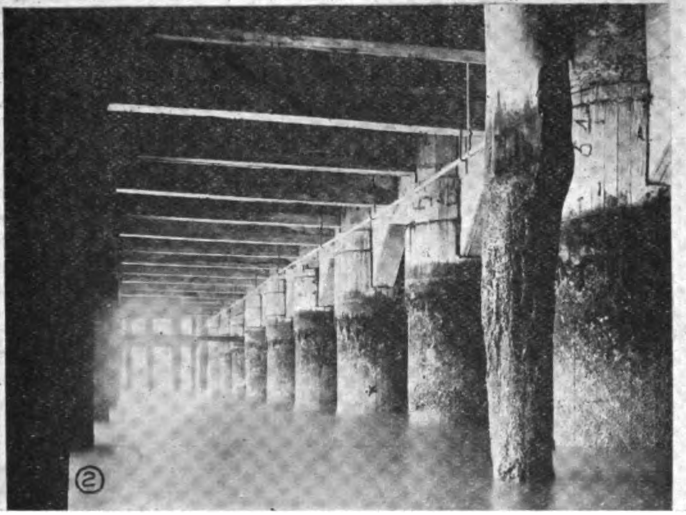
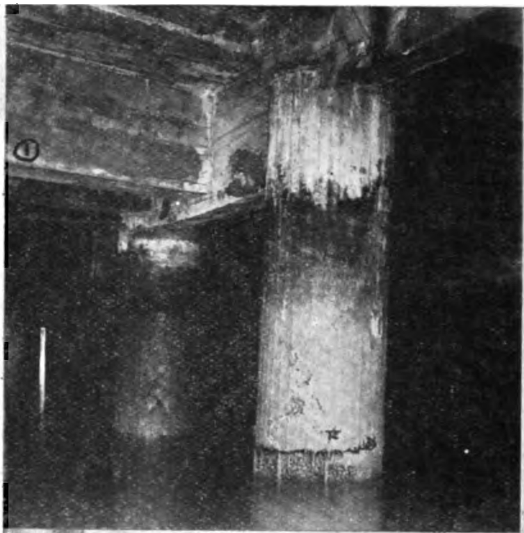


Fig. 1. Perfectly treated pile attacked by *Xylotrya*, which entered through the small knot (about ½ inch in diameter).

Fig. 2. Reinforced concrete cylinders placed in open caissons, Pier 38, San Francisco. 12 years exposure, excellent condition.

PLATE 8



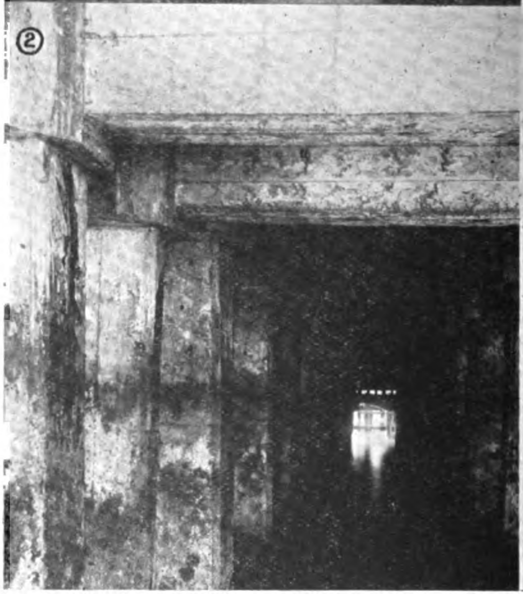
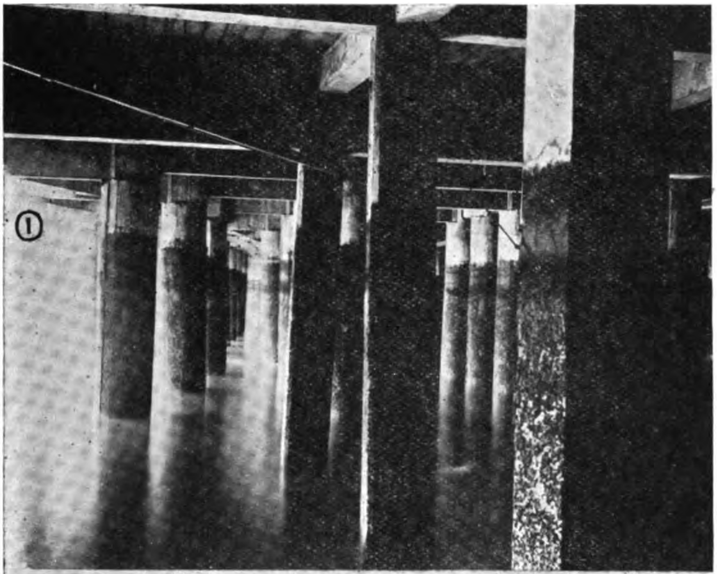


Fig. 1. Concrete cylinders Pier 28, San Francisco. Disintegration of concrete due to poor workmanship and improper tamping. These cylinders were repaired by encasing in dense concrete.

Fig. 2. Reinforced concrete piles, Pier 35, San Francisco. 6 years exposure, excellent condition.

PLATE 9



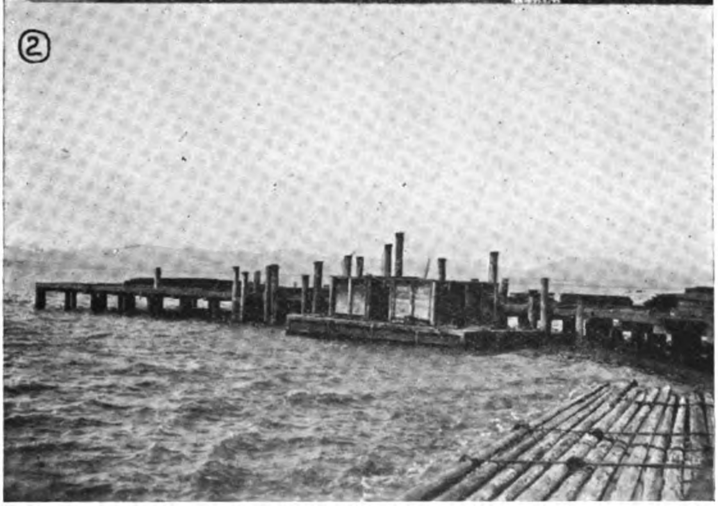


Fig. 1. Bulkhead, Pier 17, San Francisco. Foreground, reinforced concrete piles, 10 years exposure. Background, Koetitz cylinders. All in good condition.

Fig. 2. Creosoted pile raft, dogged and chained across water section of piles.

PLATE 10

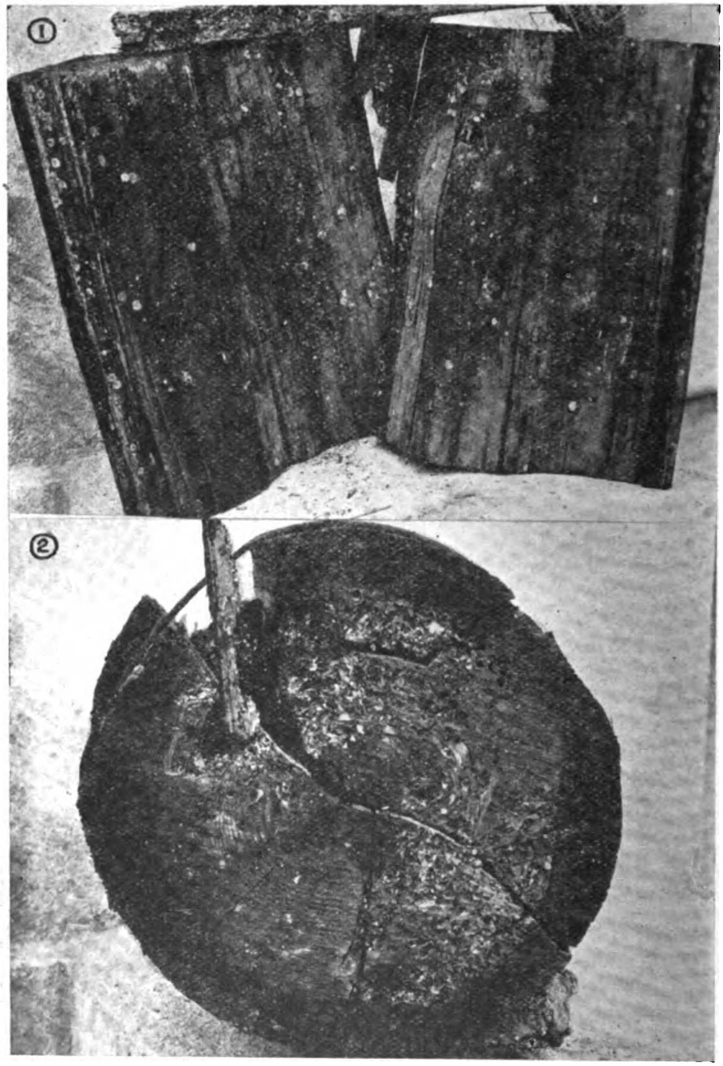
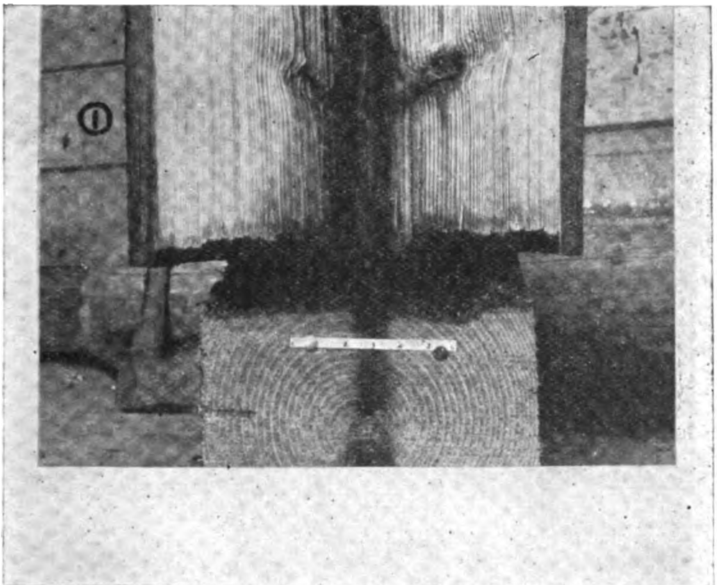


Fig. 1. Vertical section; fig. 2, cross-section, through portion of a perfectly treated pile which was split and broomed during driving. *Teredo* entered splits and worked through untreated heartwood to the creosoted outer shell, which was attacked in a few spots as shown by smaller pieces.

PLATE 11



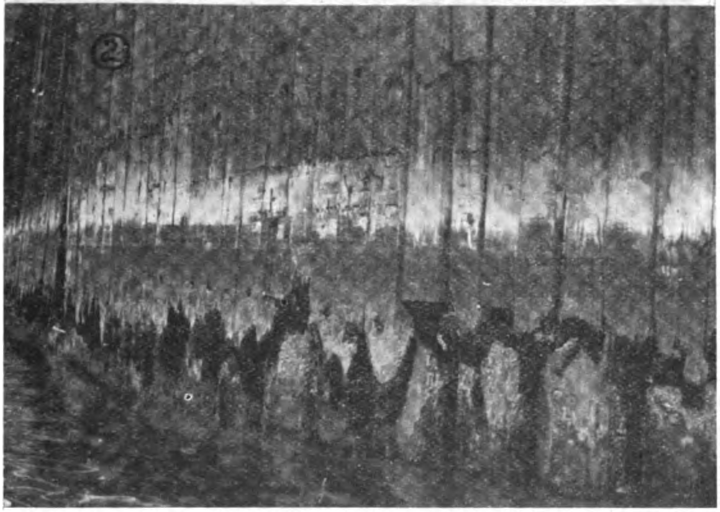
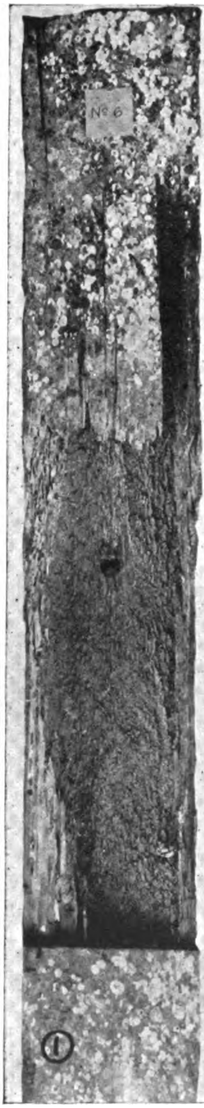


Fig. 1. Section through corbel and creosoted pile cut off too close to the water. Pile and corbel both attacked by *Limnoria*, where water stood from wave-slop. Creosoted shell of pile not attacked.

Fig. 2. Ferry Slip, San Francisco Bay. Ribbing attached below high water, as shown by bolt heads. Destruction due to *Limnoria*.

PLATE 12



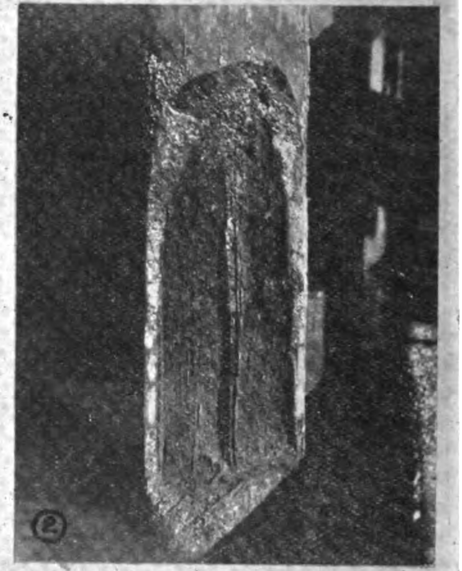
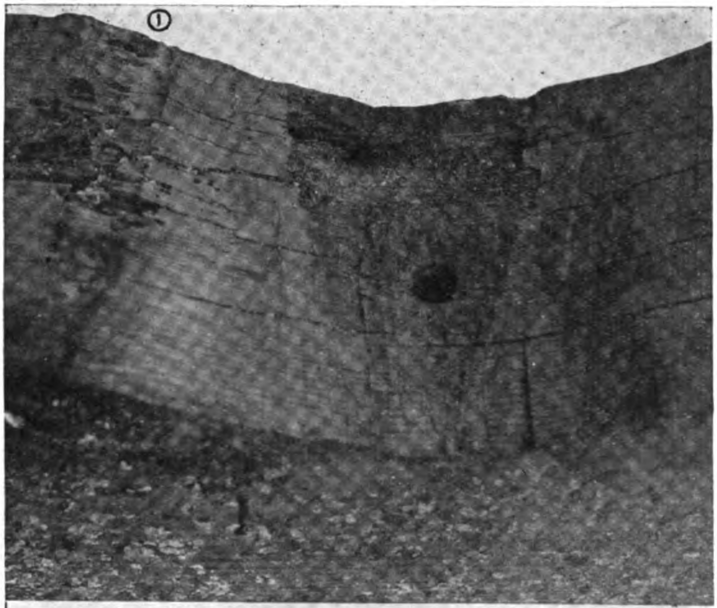


Fig. 1. Creosoted chock attacked by *Limnoria*, which gained entrance through the bolt hole.

Fig. 2. Creosoted pile attacked by *Limnoria* where pile was dapped for attaching ribbing.

PLATE 13



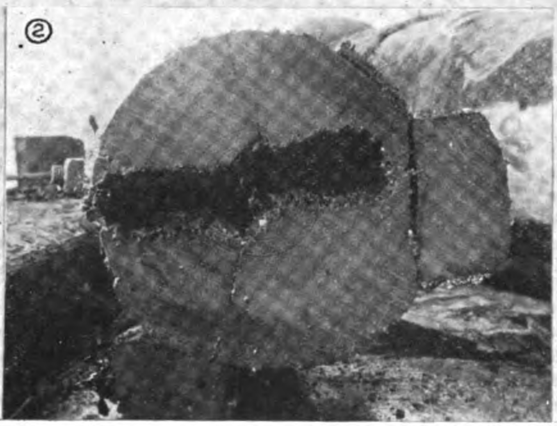
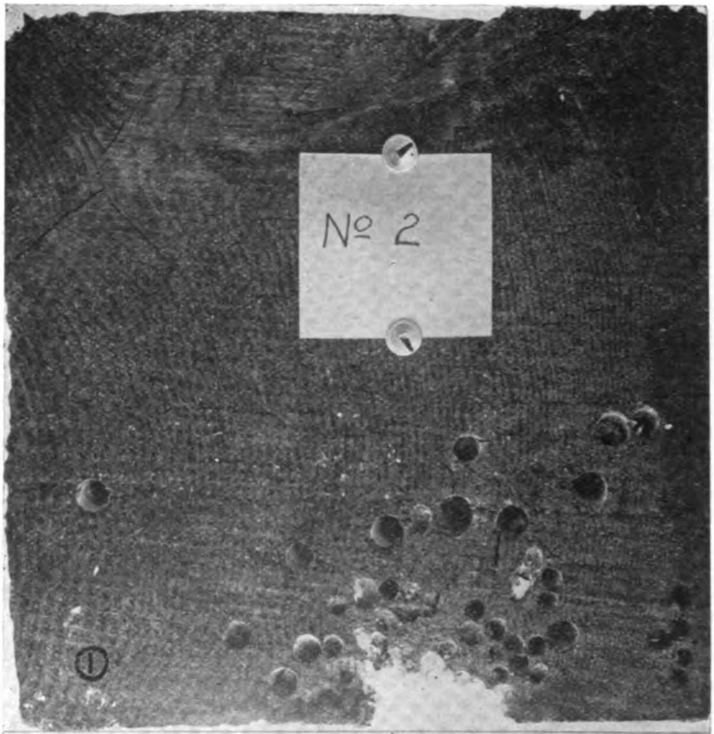


Fig. 1. Section of creosoted girt, in which untreated wood was exposed in framing.

Fig. 2. Section through creosoted fender pile attacked by *Limnoria*, which gained entrance through bolt hole.

PLATE 14



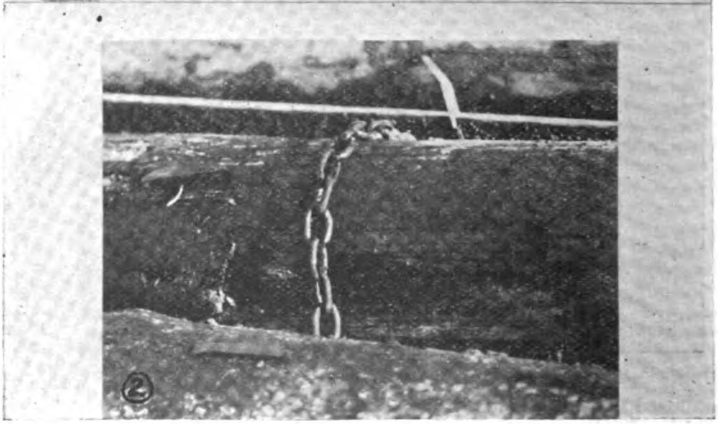
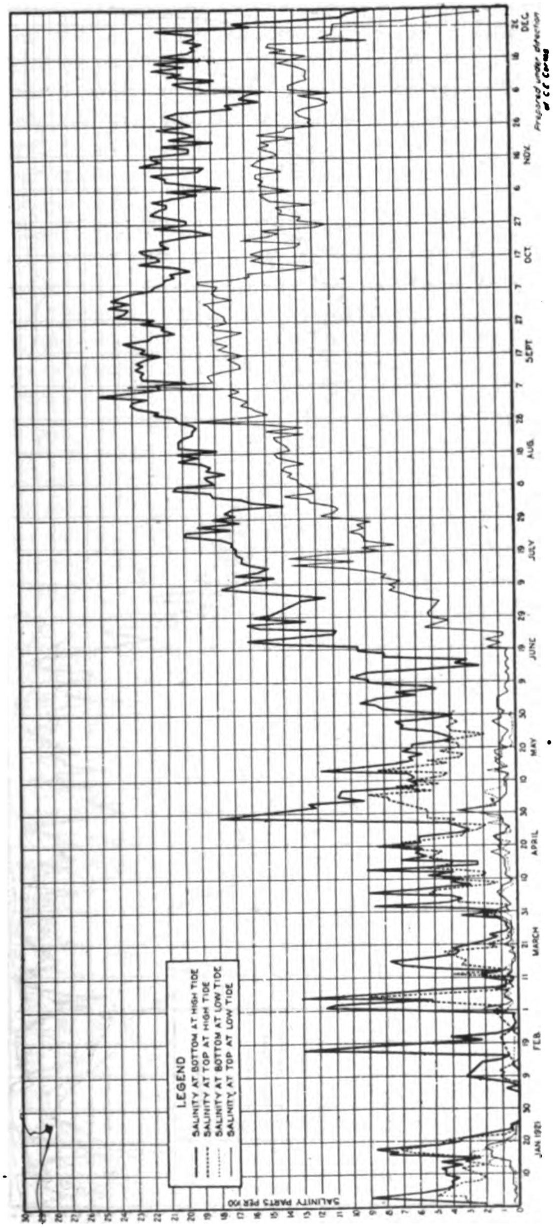


Fig. 1. End view of same girt section as in fig. 1, plate 13, showing attack by *Teredo* which entered through the untreated wood exposed by framing.

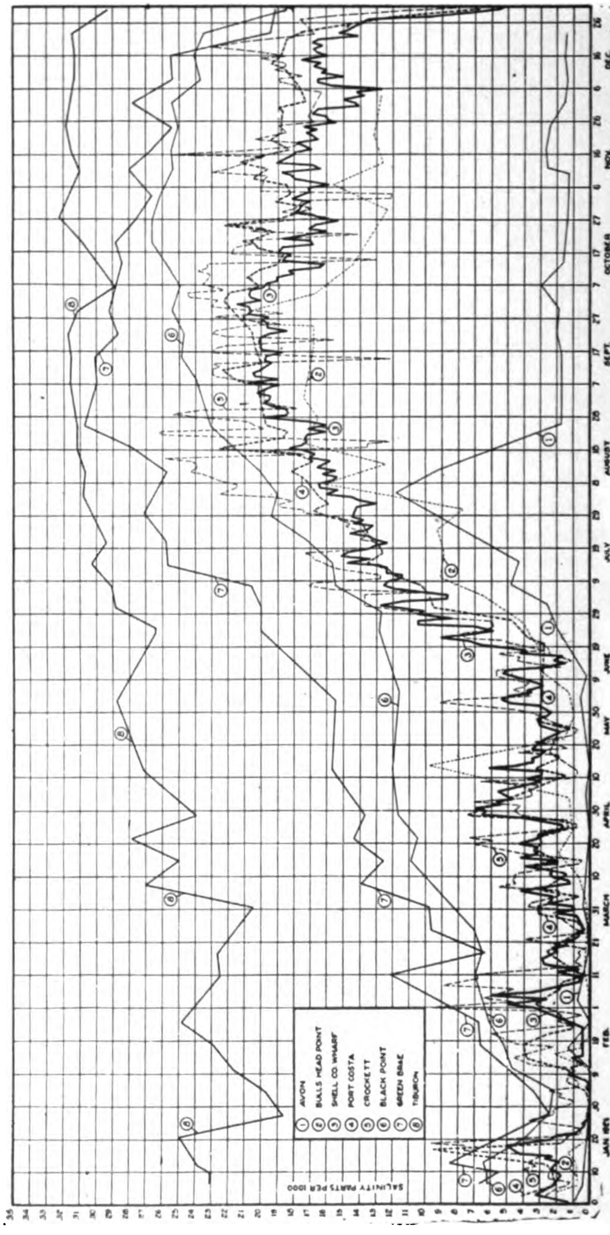
Fig. 2. Creosoted pile destroyed by *Limnoria*, which entered through a bolt hole and adjacent dog holes.

PLATE 15



SALINITY OF BAY WATER
MARTINEZ WHARF

PLATE 16



Prepared under direction of C.E. Cortes

SALINITIES IN S F BAY - 1921

MR. MATTOS: I might say that we have through committee action become primarily a regional subcommittee of the National Research Council, but it is our wish to continue to report to this Association on such matters as are of interest to the Association. I also want to state that I think we should give credit where credit is due and in concluding, I want to bring out the fact that Mr. Hill of the Forest Service, is responsible for the good shape in which the reports of the various subcommittees are presented. I move the acceptance of the report as information.

MR. ANGIER: I second the motion.

THE PRESIDENT: It is moved and seconded that the report of the San Francisco Bay Marine Piling Committee be accepted as information. There are some members here who would like to discuss this point, and we will confine ourselves to the two minute rule. This report is open for discussion at this time.

MR. HORROCKS: Mr. President, I consider this report has a great deal of value. In the first place they have established the fact, which I believe is about the first evidence that has been brought before us, that creosoted material must be taken care of properly. Eighty per cent of the damage discovered was due to mishandling. The report of the various scientific gentlemen is interesting and useful to the Committee. It does not make much difference to us what we call these bugs, but we have to bear in mind that these ship worms are proceeding with their work, boring from within, with a singleness of purpose that is absolutely alarming, and we have no time to indulge in controversies on the subject whatever, except along a direct line of accomplishing results, or they will beat us to the job. I believe the committee has done a wonderful work, and I believe in accepting this report the thanks of the Association is due this Committee.

THE PRESIDENT: Is there any further discussion of this report? Mr. Hunt will make a report on behalf of the National Research Council in connection with the Marine Piling Program as they have started it.

MR. HUNT: I have here a statement prepared by Dr. Barrows, Secretary of the National Research Council.

NATIONAL RESEARCH COUNCIL

Divisions of Engineering and of Biology and Agriculture

January 18, 1922

The National Research Council has organized a committee on Marine Piling Investigations jointly under its divisions of Engineering and of Biology and Agriculture. The Committee at present consists of the following members:

R. T. Betts, Chairman; Chief Engineer, Robbins-Ripley Co., 50 Church Street, New York.

George J. Ray, Vice Chairman; Chief Engineer, Delaware, Lackawanna & Western R. R., Hoboken, N. J.

Albert L. Barrows, Secretary; National Research Council, Washington, D. C.

Austin H. Clark, Curator, Division of Echinoderms, U. S. National Museum, Smithsonian Institution, Washington, D. C.

George M. Hunt, Forest Products Laboratory, Madison, Wisconsin; Secretary, American Wood Preservers' Association.

C. A. Kofoid, Professor of Zoology, University of California, Berkeley, California.

Hermann von Schrenk, Consulting Timber Engineer, Tower Grove and Flad Avenues, St. Louis, Missouri.

Four subcommittees have been appointed upon publicity, chemistry, engineering, and biology.

The scope of the work of this committee will cover not only the preservation of timber used in marine construction, but also investigations upon the use of concrete piling and conditions under which it may appear to be more suitable for harbor work than timber. The purposes of the committee are: (1) to effect such coordination of work already undertaken as may appear to those concerned to be desirable; (2) to encourage further investigations upon the biology of the principal wood borers; (3) to study methods both chemical and mechanical for the preservation of timber including new timber before its installation and structures already in place which may have been built of unprotected timber and later threatened by damage from wood borers; (4) and to collect information upon the use of concrete for piling, including the causes of corrosion of reinforcing steel and the failure of concrete, under marine conditions.

The committee is now seeking funds with which to carry on its work and hopes to be able to place these operations in charge of a director who will give his full time to the enterprise.

The committee is particularly desirous of enlisting the cooperation of groups of men in various ports of the United States for the purpose of undertaking local investigations and surveys of marine borer conditions, and also the assistance of all bodies throughout the country which are interested in this problem. Announcements concerning the development of these plans will be made from time to time in the scientific and technical press and also through direct correspondence. Advice and suggestions will at all times be welcomed.

MR. HUNT: I may say it is not the intention of the National Research Council to take any work out of the hands of any organization. Their business is to induce more people to work, get as many organizations and individuals working as possible. This Committee, and the National Research Council, simply plan to stimulate the work and act as sort of clearing house for harmonizing results.

THE PRESIDENT: Are there any other comments in connection with this report? As a vote of confidence in the San Francisco Committee I wish you would all rise in an affirmative vote on this motion. All in favor of that motion as given please rise. Those opposed. It is unanimous.

I think the two gentlemen who have come on from the Coast can see how confident we are in their work.

MR. JURS: Mr. Chairman and Gentlemen: We want to thank you from the bottom of our hearts for your kindness.

THE PRESIDENT: The Gulf Coast people have seen fit to arrange a marine-piling program somewhat similar to the San Francisco work under way, and Mr. Boehne will give the status of that work at this time.

MR. BOEHNE: Mr. President and Gentlemen: You can quite readily understand that a newly-appointed committee having in charge the work of the investigation of marine piling on the Gulf Coast is not going to present any kind of haphazard report in view of the splendid report we have received from the San Francisco Bay Piling Committee. The investigation on the Gulf Coast will necessarily have to be carried out along lines similar to those employed in San Francisco Bay. Just how far we can go is still quite a problem. We have different conditions along the Gulf Coast than exist in San Francisco, inasmuch as throughout the Gulf Coast for years past, creosoted material has been quite generally used. As a consequence there has not been a sudden loss which has created a world of interest as did occur in San Francisco Bay. The interest in the proposed investigation must be created by calling the attention of the various industries who have structures in marine waters, to any loss which may be occuring although we cannot anticipate receiving reports of losses to any great extent.

Furthermore, when the work was suggested by the Executive Committee of the Association and the Committee appointed by your President, the name of the Gulf Coast Marine Piling Survey was given the Committee. Now imagine what that means, The Gulf Coast extends from Key West to Brownsville, Texas, a distance of approximately 2,000 miles of Gulf Coast. There are approximately 35 or 37 ports and sub-ports, each one of which has creosoted material installed and each of which possibly has different conditions; so you can see it is quite an undertaking. The Committee appointed worked to devise some means and some method of starting this investigation; the program or suggested program was made out and submitted to the President and in turn to the Executive Committee and received their approval. Now we have to raise the money. The Association is without funds for this purpose. As I said a moment ago, there is not the individual interest, nor is the interest in this investigation localized. The necessary money must come from the people who are going to receive the benefit of such an investigation. It is therefore, necessary to secure their commitments before we can go very far. Again, you see that is a task. If it takes $30,000 to carry on the marine piling investigation in San Francisco Bay, how much money is it going to take to carry on the investigation of 2,000 miles of Gulf Coast. Again I say, it is an undertaking of no mean magnitude. We have not gone very far. The work is in a formulative stage. At some time in the future, if the Executive Committee approves of what is being done and of suggested plans which may be presented and with the co-operation of the National Research Council, we are hopeful that something will be presented to you next year, but nothing this year.

THE PRESIDENT: There is one other Committee that was appointed this last year, as a co-operative joint committee on wooden-highway-bridge design. Mr. Ericson, who is our active member on that Committee, will make the report at this time, as to progress. Mr. Ericson.

MR. ERICSON: There really is not any report to make at this time. The Committee has just been organized; the personnel is given in the program.

We had one preliminary meeting in New York. We are confronted with a condition, and not a theory. It has been brought to our attention that creosoted timbers on bridges caught fire, and the bridges have been destroyed. In a great many cases these bridges have had a steel superstructure, and the heat has been so intense that the steel has collapsed long before the wood itself was destroyed by the fire. There has been little, if any, thought given, in the design of bridges, to the factor of fire hazard. I think we are safe in saying that there are a great many bridges in this country which are subject to the same peril, and might be destroyed if the conditions were right. We will require a great deal of assistance if we accomplish the purpose which we are setting out to do. We don't ever hope to be able to make these bridges fireproof, but we expect to recommend construction which will make them slow burning, and if we can make them slow burning, we will have accomplished the result we have set out to do. In most cases, when these fires have started, the entire structure has been enveloped in flames before anybody realized what was going on.

In a great many cases the best information we will get will be information which will be voluntarily submitted. We expect to get in touch with the railroads and with the bridge departments of the larger cities and through the National Bureau of Roads at Washington we are getting in touch with the various states in connection with their highway bridge construction.

It is a fact that bridge engineers in this country are getting to the point where they fear to use or to specify creosoted timber in bridge construction. We must disabuse them of the idea that to use creosoted wood in their bridge construction they have to risk its total destruction at any time without warning on account of fire. There has been a tendency on the part of some people to recommend that this matter be hushed up, but we do not believe that is the way to attack the problem at all. There are others who will say if wood is properly treated, with the proper kind of oil, it won't burn, but it is a fact that it does burn and that is what we have to face. We have a number of plans in view, but we really have not studied the subject deeply as yet. I know that the committee will need the help of everybody and will want the ideas of everyone to assist them.

THE PRESIDENT: That completes the formal program. Has any one anything to say at this time? Next will be the report of the Resolutions Committee. Mr. Moses then read the first Resolution as follows:

RESOLUTION No. 1.

WHEREAS, in the reorganization of our departmental service at Washington it has been proposed to transfer the Forest Service from the Department of Agriculture to the Department of the Interior:

RESOLVED, that in the judgment of this Association the Forest Service should be retained under the Department of Agriculture, and

RESOLVED, that this Association favors the additional appropriation of $100,000 desired by the Forest Products Laboratory for the fiscal year beginning July 1, 1922, for the purpose of giving publicity to data already collected, to make commercial demonstrations and to maintain better contact with the wood-using industries, and

RESOLVED, that a copy of this resolution be forwarded through regular channels to the Secretary of Agriculture.

THE PRESIDENT: What is your pleasure in connection with this resolution, gentlemen?

MR. WATERMAN: I move the adoption of the resolution.

MR. ANGIER: I second the motion.

THE PRESIDENT: It is moved and seconded that this resolution as read be adopted. All in favor please say "aye"; opposed, a like sign. It is so ordered.

RESOLUTION No. 2.

WHEREAS, The American Wood-Preservers' Association has noted with interest and gratification the splendid work being done by the Department of Commerce in securing co operation between the various industries of the country,

NOW THEREFORE BE IT RESOLVED that this Association extends to the Department of Commerce its sincere congratulations on the effective work already accomplished, with assurances of the Association's cordial support in any further efforts of the Department.

THE PRESIDENT: All in favor of that resolution as given please say "aye"; opposed, a like sign. It is carried.

MR. MOSES: The next resolution is one which may have been superseded by the Resolution offered by Mr. Joyce and passed this morning, and it has been suggested that the resolution be withdrawn. In the absence of the Chairman I do not feel authorized to take that action, and I place the resolution before you for your action. As a matter of fact some members do not feel that it should be withdrawn. I was instructed by Mr. Briggs in presenting this resolution to make it clear, however, that the committee had no thought of suggesting that this Association believes the Department of Agriculture the proper source to which to go for any action relating to accounting methods on the railroads, but that it was thought as a matter of public policy the feature of forest conservation might properly be brought to the attention of the Interstate Commerce Commission through the American Railway Association, or otherwise. This is the resolution:

RESOLUTION NO. 3.

WHEREAS, The Interstate Commerce Commission has ruled against authorizing railroads to charge excess cost of treated ties and timber to Capital Account, and

WHEREAS, This Association fully recognizes the many serious obstacles from an accounting standpoint to the granting of such authority, and

WHEREAS, The more general use of treated material would render effective aid in forest conservation, a matter of profound interest to every citizen of the United States and particularly to quantity users of forest products, and

WHEREAS, This Association believes that the Interstate Commerce Commission would gladly co-operate with the Department of Agriculture in every consistent way toward effective forest conservation.

NOW THEREFORE BE IT RESOLVED that the Executive Committee of the American Wood-Preservers' Association be requested to appoint a special committee charged with the duty of making a thorough investigation of this subject, in co-operation with the Forest Service in the Department of Agriculture, and reporting to the next annual meeting of this Association its recommendations as to the best method of presenting this subject for rehearing by the Interstate Commerce Commission.

BE IT FURTHER RESOLVED that copy of this resolution be transmitted to the Secretary of Agriculture through proper channels soliciting his co-operation and advice.

MR. MOSES: I was also instructed by Mr. Briggs to say that this resolution was prepared after reading Mr. Stimson's paper, and without the slightest thought of criticising his decision (which it might be added the Committee thought eminently proper at the present time, and we assumed that the Committee recommended in the resolutions will either include Mr. Stimson or confer with him.)

THE PRESIDENT: What is your pleasure, gentlemen, as to this resolution? Is there a motion that it be adopted?

MR. REX: Mr. Chairman, I move that we adopt this resolution.

MR. ANGIER: I second the motion.

THE PRESIDENT: It has been moved and seconded that the resolution, as read, be adopted by the Association. Are there any remarks? Are you ready for the question? All in favor of that motion please say "aye"; opposed a like sign. The motion is carried.

WHEREAS, Death has removed from our midst, our worthy member, J. D. Grant,

BE IT RESOLVED, That the American Wood-Preservers' Association tender the relatives of the deceased heart-felt sympathy in their bereavement, and

BE IT RESOLVED FURTHER, That the Secretary forward a copy of this resolution to the family of Mr. Grant.

THE PRESIDENT: Those in favor kindly stand. You are unanimous.

RESOLUTION No. 4.

WHEREAS, Death has removed from our midst, our worthy member, E. J. Allen,

BE IT RESOLVED, That the American Wood-Preservers' Association tender the relatives of the deceased heart-felt sympathy in their bereavement, and

BE IT RESOLVED FURTHER, That the Secretary forward a copy of this resolution to the family of Mr. Allen.

THE PRESIDENT: Those in favor kindly stand. You are unanimous.

MR. MOSES: I should perhaps say that the Resolutions Committee simply followed the form heretofore set for these resolutions but felt that in the case of the death of conspicuously prominent members of the industry special resolutions would be in order and therefore presents the following resolution with regard to the death of A. T. Hert.

RESOLUTION No. 5.

WHEREAS, Since the last annual meeting of this Association death has claimed our distinguished fellow citizen and associate member, Albert T. Hert, and

WHEREAS, In the death of Mr. Hert the industry represented by this Association as well as the nation at large has lost a great and useful citizen, the Association feels that it is proper to record the appreciation of its membership for the valuable and constructive work done during the past 18 years by this pioneer in the industry of wood preservation.

Since 1904 Albert T. Hert, through his various enterprises, stood constantly for the best practices in wood preservation and did much to further the objects for which this Association stands. His death is deplored not only as a personal loss to our members who had the privilege of his friendship, but to the entire industry and to the nation.

RESOLVED, That this resolution be spread upon the minutes of the Association and copy forwarded to the family of the deceased with the sympathy of the American Wood-Preservers' Association in their bereavement.

THE PRESIDENT: All in favor kindly rise. You are unanimous.

MR. MOSES: That, Mr. Chairman, concludes the report of the Resolutions Committee.

THE PRESIDENT: We next have the proposed amendments to the constitution which the Secretary will read.

THE SECRETARY: The following proposed amendments to Article 2 of the constitution were submitted to the Secretary in compliance with the requirements of Article 9 in a communication approved by J. B. Card, Walter Buehler, G. E. Rex, E. A. Sterling, and J. H. Waterman. They are therefore legally entitled to be voted upon at this convention.

Article II, Section 3. Eliminate the words: "or association of persons."

THE PRESIDENT: Is it your pleasure to vote on these separately? There is no response, so we will have them all read.

THE SECRETARY: Section 10. "A corporate member elected after January 1, 1922, who assumes a position not complying with the requirements of Article II, Section 2, shall cease to be classed as a corporate member but may retain his membership in the Association as an associate member, subject to the provisions of Article II, Section 3."

Section 11. "An associate member who assumes a position qualifying him to be a corporate member, according to Article II, Section 2 automatically becomes a corporate member, subject however to Article II, Section 10, if he becomes ineligible to continue as a corporate member."

THE PRESIDENT: What is your pleasure, gentlemen?

MR. MATTOS: I move the adoption of those changes in the constitution and by-laws.

MR. MEYER: I second the motion.

THE PRESIDENT: It is moved and seconded that the amendments to the constitution as read be adopted. The motion now is before you for discussion.

MR. FOLEY: Mr. President, I move the amendment of the motion made, by the omission from the first line in Section 10 of the words "elected after January 1, 1922." The significance in those few words lies in the change they make in the status of certain members. From its beginning this Association has maintained a distinction between those engaged in wood preserving and those selling materials to be preserved, preservatives, or preserved wood. The propriety of the distinction has not been questioned by the supplymen—it is no discredit to them—most of them believe that the Association is in a stronger position for presenting its policies because they have no chance to either vote or hold office. Now it is proposed to make it possible for some of you or me, just because we happened to come into the Association prior to the first of this year as a Corporate Member, to continue voting and holding office after we may go into a business of selling lumber or ties, preservatives, machinery, and so forth, as is done by Associate Members, while others of you, just because you happened to come into the Association since the first of the year as Corporate Members, have to become Associate Members as soon as you engage in a supply business.

MR. SCHNATTERBECK: I second the amendment.

THE PRESIDENT: It is moved and seconded that the motion be amended by striking out the words "elected after January 1, 1922". Are there any further remarks?

MR. KUEHN: Mr. Chairman, I don't think that is right. We made a contract with a man under certain conditions, when we accepted his membership, and it is more than likely that man may have been a very valuable and effective man. Now let us make a new deal. That is the reason for that date. Don't let us go back on the deal that we made with the man when he entered the Association. That has been tried in a number of associations, and it is hardly fair.

MR. WATERMAN: Mr. Chairman, this Committee considered very carefully the proposition which Mr. Foley has presented in the amendment to the motion, and I do not believe the men in this convention are going to throw out men that have helped build it up from the foundation just because they have stepped out in another line. [*Applause.*] As I understood my friend over there to the left, this is a new contract. We are not fooling anybody. Any one that comes in in the future will understand that as long as he continues as an active member, according to the constitution and by-laws, he is an active member, but if he goes out and runs a side show of some kind or goes into active business, in some legitimate,—and of course they wouldn't go into anything but legitimate business. [*Laughter.*] They understand that they are automatically barred from membership as this article indicates. Now I trust you have the confidence in the men that have proposed Article II, that you have confidence in those men that they considered all sides of the case.

MR. FOLEY: Mr. Chairman, the Constitution has always provided, as it does now, for the principle that those who sell materials to wood preservers shall not vote or hold office. None of the revisions of it, which have made more definite the qualifications for membership, have violated this principle, or shifted it to apply only to a member's status when admitted, as was suggested. The Constitution provides that "a Corporate Member *shall be* an executive, an administrator, or an operative in a wood-preserving organization, etc." It does not say "*shall have been.*" The requirements for maintaining a specified membership are no different from those for acquiring it. Since "an Associate Member *shall be* any person interested in the sale of material or equipment used in the wood-preserving industry," our records should not label some such individuals Corporate Members and deny to others equally wise and worthy the right to vote and hold office. The wording of the Constitution up to the present justifies no member in assuming that admission as a Corporate Member meant continuance as such after the requirements of such membership could not be met. The proposed amendment does not change the Constitution in that respect. The latter will still say that those "interested in the sale of material or equipment" shall be Associate Members; but the amendment proposes to legalize the violation of the Constitution in its application up to 1922, and then to reaffirm the principle which has prevailed in print all the time that only those who are in wood-preserving organizations shall be Corporate Members. So as a matter of fact the proposed amendment would actually make the Constitution to-morrow what it was yesterday, but today would sanction the continuance for all time as Coporate Members of certain individuals who in the spirit of the Constitution in the past and in the future should be Associate Members. Our membership list should correspond with the constitution in the designation opposite our respective names. We should not have to concern ourselves over any individual being labeled a Corporate Member and yet engaged in a business no different from that of an Associate Member.

MR. ANGIER: The interpretation that Mr. Foley has placed on this has not been followed in the past. For many years then we have been following a wrong practice. I do not think at this time that we should go back. Therefore, I am heartily in favor of what Mr. Waterman said, to vote against the amendment.

MR. CRAWFORD: Mr. President, Mr. Foley has read a portion of the constitution and then placed his interpretation upon it. I think it is possible to put another interpretation upon that "shall be". Does that "Shall be" mean that he shall be such and such at the time he is taken into the Association, or does it mean he shall be such and such and forever remain so? Now the interpretation that I put upon that "shall be" is that he shall be so and so at the time he is taken into the Association. Then you make your contract with him. If he goes into some other business or if he in any way does anything that jeopardizes the good name or the good purpose or the motive of this association, then there is also a provision and a way in which he shall be taken care of, and the Executive Committee then has a right to act, but if he is taken into the association and fulfills the requirements that are specified in the constitution at the time he is taken in, I cannot see then why he should be thrown out until he does something to violate another section of the constitution which gives the Executive Committee a perfect right to act (applause).

THE PRESIDENT: Mr. Kuehn, you went through this thing in another organization, didn't you?

MR. KEUHN: Yes, sir.

THE PRESIDENT: Will you tell how it happened there? Mr. Kuehn was formerly a railroad man and rightfully a member of the A. R. E. A. Later he went into a very remunerative business. [*Laughter.*] He was one of those men who had joined the A. R. E. A. early. The A. R. E. A. was confronted with the same problem and I would like him to tell how they handled it.

MR. KUEHN: Mr. Chairman, you just haven't the facts, that is all. I joined after that rule was made, and therefore accepted that condition. I stepped into associate membership.

THE PRESIDENT: Is it not also true that that rule was put back?

MR. KUEHN: No, sir.

THE PRESIDENT: Back dated?

MR. KUEHN: No, sir. That is just the point that I made. It has been tried and they could not get it over, because they had made an honest deal with the man and they could not change it.

MR. MOSES: Mr. Chairman, I was just going to say and I think we might just as well be perfectly frank about it and say what Mr. Waterman doubtless has in mind, that in the early struggling days of this Association it would have fallen through if it had not been for some of these men who would be barred if this amendment is adopted. I hope it will be voted down.

MR. WATERMAN: You bet your life. That is it exactly.

THE PRESIDENT: Are there any other remarks? We are voting on the amendment now.

All in favor of the amendment as made by Mr. Foley kindly say "aye;" opposed, a like sign. The amendment is lost.

We will now vote on the motion as originally placed. Are there any other remarks, or any other amendments? All in favor of the amendments as proposed please say "aye;" opposed, a like sign. Two-thirds carry, and it is so ordered.

We will next have the report of the Tellers' Committee.

MR. MATTOS: Mr. President, the Tellers' Committee wants to announce the result of the ballot taken on the officers of the Association.

For President, F. J. Angier. [*Applause.*]

For First Vice-President, W. H. Grady. [*Applause.*]

For Second Vice-President, H. S. Sackett. [*Applause.*]

Secretary-Treasurer, George M. Hunt. [*Applause.*]

For Executive Committee, O. C. Steinmayer and E. J. Stocking.

For Nominating Committee, E. E. Alexander, W. L. Bacon, S. D. Cooper, R. F. Hosford, R. S. Manley and Robert H. Moore. [*Applause.*]

THE PRESIDENT: Will the Past Presidents present kindly step forward.

(Mr. Buehler, Mr. Card, Mr. Crawford, Mr. Foley, Mr. Joyce, Mr. Rex, and Mr. Waterman then took places on the platform.)

THE PRESIDENT: It gives me great pleasure to ask that Mr. Waterman conduct the new President to the Chair.

PRESIDENT-ELECT ANGIER: Fellow Wood-Preservers, words fail me to tell you how pleased I am with the honor that you have conferred on me the greatest honor that you can bestow upon a fellow member. I am especially pleased because for eleven years I was your Secretary-Treasurer, one year your Vice-President, and now over the top.

James J. Hill said you cannot build a reputation on the things you are going to do. Gentlemen, I am not going to stand here and tell you what I am going to do, but I want to tell you about one or two things that I would like to do, with your approval.

I would like to have my administration what you might call a conservation administration. I want every member of this Association to uphold me and to uphold the Service Bureau in educating the public to the great necessity of treating timber. Of the fifty billion or more board feet of timber that is cut and used in this country today only about four per cent is treated, and we should treat at least 20 per cent. We need more plants, and we need to treat more timber. About two billion board feet of timber is used in car construction, and hardly a piece of it is treated. There is no doubt but that we should treat a lot of it.

There are other things that we should do this year. One that stands out at the present time is to increase our membership. We will have a committee to carry on a campaign for new members. The slogan of this committee is "One Thousand Members Before Meeting Again". [*Applause.*] While we may not get one thousand members, let us get as many as we can.

I would like to adopt this slogan for the year 1922, "I WILL." When we say to you, Bring in one new member, your answer should be, I WILL. When we ask you to work on committees, you should accept service and say I WILL. If you will keep in mind this slogan, I WILL, we will make the year 1922 one of the best years in the history of our Association. [*Applause.*]

MR. WATERMAN: Mr. President, it is a very great pleasure to me to welcome you or to congratulate you on your being the President of the American Wood-Preservers' Association. It is not only a pleasure to me, but it is a pleasure to every man here. Every man here realizes the wonderful service which Mr. Angier gave this Association for eleven years, as its secretary. [*Applause.*] When he took hold of it there were very few members in the organization, and it was a question, as our friend, Moses, said a few moments ago, whether we should live or die. Mr. Angier worked early and late. I presume if he would bring in the correspondence that he has had during the years he was Secretary, that you would have to get a 15-ton truck to haul it, for he is a great fellow to write letters. [*Laughter.*]

Now, my friend Angier, here are eighteen flowers representing the eighteenth annual convention of the American Wood-Preservers' Association. We are going to start you out with flowers, but if you get off the track you will find yourself in thorns. Don't worry about the thorns. Just pick them out. No man that is a man through and through is injured when he is criticised if the criticism is constructive criticism. So, young man [*laughter*], when you get off the track we will spur you with thorns, in other words, we will criticise you not to injure you but to lift you up. As I illustrated yesterday, we are going to let the dross go down the valley, but the gold we are going to find in the bottom of the pan. We all wish for you the greatest success, and we all will say I WILL. Won't you repeat it with me now, gentlemen? (All together) I WILL. [*Applause.*]

MR. REX: Gentlemen, of course it is useless for me to try in any way to duplicate the eloquent words of our past President, Mr. Waterman. We all thoroughly appreciate the wonderful speech he has made to Mr. Angier. It would put enthusiasm in a stone man. He suggests that after the roses are gone the thorns come. Gentlemen, It is going to take something besides thorns to accomplish the task Mr. Angier has set himself to. He is going to need something harder than a thorn to get the results we are after and so our good friend, Mr. Hosford, has presented us this morning with a gavel (inspectors hammer) which we think can drive these accomplishments. I now present this beautiful, hard-earned, long-service gavel to Mr. Angier, and I hope that any man that does not answer his letters, any man that does not cooperate with him in every request, will get this, not the blunt end, but the pick end. [*Applause.*]

MR. ANGIER: I shall try to use the gavel with pleasure to myself and honor to the fraternity.

MR. KUEHN: Mr. Chairman, now that the elite have spoken, a word is in order from the rabble, as it were. [*Laughter.*] I had the privilege some few years ago of being a member of the Committee to revise the constitution. The prime thought and the thing which was in the minds of that committee was to make it possible to put at the head of our Association a man of experience, a man who had been tested out in the various lower offices of the association. We have looked Mr. Angier all over, top and bottom, back and forth, for eleven years, we have seen Mr. Angier under the most trying circumstances and in the most trying office. Some of us know, I believe, what that work is, and I believe our new Secretary will know if he thinks of multiplying his last year's work by eleven, what Mr. Angier has done for us. It is a privilege to us, it is a repayment of a debt, to take Mr. Angier as our leader in recognition of his ability to fill the office. [*Applause.*]

MR. ANGIER: Gentlemen, I thank you for these compliments. It only demonstrates to me more than ever the need of the eloquence of Mr. Waterman. If I could talk like he can I would tell you how I feel about it. (Mr. Angier then took the chair.)

THE PRESIDENT: Will Mr. Gibson escort the first Vice-President, Mr. Grady, to the chair?

(Mr. Grady was escorted to the chair.)

THE PRESIDENT: Gentlemen, it is with great pleasure that I introduce to you Mr. W. H. Grady, your first Vice-President. I have known Mr. Grady for some time and I know that he is all wool, and a yard wide. [*Applause.*]

MR. GRADY: Mr. President and Gentlemen: I know we have all had about all the speeches and committee reports we can stand up to this time. I would not take up your time with a speech even if I could give you one, like Mr. Angier and Mr. Waterman and some of these other men. I just want to thank you for the compliment and to tell you I appreciate the honor and the compliment you have paid me.

THE PRESIDENT: Mr. Sackett has been elected second Vice-President. Is Mr. Sackett here?

MR. TAYLOR: Mr. President, he could not be here an account of a wreck on the Milwaukee. He has to stay in his office to reroute a lot of material. He wishes to thank the Association for the honor paid him, and says he will fulfill the office to the best of his ability and trusts he will have your confidence.

MR. WATERMAN: We would like to hear from the Secretary, Mr. Hunt.

THE PRESIDENT: Mr. Past-President Taylor, will you kindly escort Mr. Hunt to the platform?

THE PRESIDENT: Gentlemen, Mr. Hunt needs no introduction. We have at last, after eighteen years, gotten a real live secretary. [*Applause.*]

MR. HUNT: If he serves eleven years he won't be alive any more. [*Laughter and applause.*] I now understand why some of the hairs in Mr. Angier's head are gray. I do not think any one else in the Association appreciates the work that Mr. Angier has been through, and as I look forward through the years to come, to the growth that is going to come to this Association, especially in the present year, when Mr. Angier and all of us are going ahead to try to build it up, and make it more powerful, I am convinced that the time has come when we must have a different method of handling our Secretary's office. The work is becoming too important and there is too much of it for one man to handle on a part time basis—to spend the time on the Secretary's office that he has not use for elsewhere. It is too big and too important for that. So my principal hope is that the present year will find a better way of handling this business, and that in itself will be a great impetus to further the progress of the Association. [*Applause.*]

THE PRESIDENT: Gentlemen, the next thing is to vote on the city in which we will hold our next convention. I believe the Secretary has some invitations from various cities, and will make a brief announcement.

MR. HUNT: Gentlemen, the Wood-Preservers' Association is becoming more and more popular as is evidenced by this list of invitations. I will not read the invitations but merely the list. Since October up, to the present time, we have been receiving a continuous stream from Asheville, Atlantic City, Birmingham, Buffalo, Chattanooga, Cleveland, Detroit, Los Angeles, Milwaukee, New Orleans, New York, Philadelphia, Pittsburgh, Saint Louis, San Francisco, Washington and West Baden.

THE PRESIDENT: Gentlemen, nominations are in order.

MR. ROACH: I would like to nominate New Orleans as the next convention city because we want the convention there presided over by the man who has done the most for the Wood-Preservers' Association to date.

MR. HARPER: I second the nomination.

THE PRESIDENT: Gentlemen, New Orleans has been nominated. Are there any other nominations?

MR. BOEHNE: Mr. Chairman, I move the nominations be closed.

(Motion seconded by several.)

THE PRESIDENT: It is moved and seconded that the nominations be closed. Are you ready for the question? All in favor say "aye"; contrary, the same sign. It is carried. [*Applause.*]

Gentlemen, New Orleans is our next meeting place.

The Secretary has just called my attention to the fact that the Auditing Committee has not made their report. We will call for the report of the Auditing Committee at this time.

MR. SCHNATTERBECK: Gentlemen, your Auditing Committee has carefully checked the data to prove the report of the Secretary-

Treasurer which was prepared on the same lines as his predecessor for eleven years, and your Committee found the same to be correct.

Permit the question: How many members know what the assets and liabilities of the Association really are? For years the annual report has shown only the money handled by the Secretary-Treasurer during his twelve months' incumbency. We do not know the value of our assets in the form of publications unsold, nor do we know the amount of money owed by members in arrears for their annual dues. These facts, we believe, should be shown in an annual report to apprise the members of the real assets and liabilities of the Association which is a corporation.

Gentlemen, we must admit that the clerical help the Secretary has is necessarily limited by the small amount of money appropriated for that work. In order to inaugurate a more modern system of bookkeeping it would be necessary to have more help, preferably permanent help, and that, of course, would mean the expenditure of more money which can only be raised if we get more members and increase the sale of our publications. That is a question for the Executive Committee to decide, which they can do better than we. [*Applause.*]

MR. WATERMAN: I move the report of the Auditing Committee be adopted.

MR. HOSFORD: I second the motion.

THE PRESIDENT: Gentlemen, you have heard the motion. Are there any remarks? If not, those in favor of the motion please say "aye"; opposed, "no". The motion is carried.

At two-thirty, in this hall, the Tie Producers' Association will open their meeting. I have been requested to say to you that you are all cordially invited to attend.

Remember, please, that we want every member of the Association to bring in one or more new members this year. Repeat after me I WILL.

(All together) I WILL.

The Meeting then adjourned.

STATISTICAL DATA

QUANTITY OF WOOD TREATED AND PRESERVATIVES USED IN THE UNITED STATES IN 1921

By R. K. Helphenstine, Jr.
United States Forest Service

Summary

The 122 wood-preserving plants in the United States that were active in 1921 treated 201,643,228 cubic feet of wood. This represents an increase of 28,333,723 cubic feet, or nearly 17 per cent, over the quantity treated in 1920 by the 112 establishments that were in operation during that year.

No small portion of the above mentioned increase was brought about by the added number of crossties and the increased quantity of construction timbers treated during the year. Of the ties there were treated in 1921 a total of 55,383,515 as compared with 44,987,532 the year previous. Of the construction timbers 142,520,494 board feet were run through the cylinders during the period covered by this report, while in 1920 the quantity subjected to treatment was only 139,749,738 board feet. The quantity of piling impregnated with preservatives during the year was 8,268,519 linear feet, or less by 3,697,393 linear feet than was reported in 1920. Slight increases were registered in the number of poles and the quantity of wood blocks treated during the year, while the number of cross arms reported was only 175,403, or less by 338,807 than the number treated the year previous.

In the preservation of wood in the United States in 1921 the treating plants consumed 76,513,279 gallons of creosote'* 1,060,753 gallons of paving oil, 1,810,294 gallons of miscellaneous preservatives and 51,375,360 pounds of fused zinc chloride. The zinc chloride consumption in 1921 was the largest so far reported by the industry and represents an increase of 1,657,431 pounds over the quantity used the year before.

The quantity of creosote used during the year constitutes an increase of 7,755,771 gallons over that consumed in 1920, while

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* In this report creosote includes imported oil, distillate coal-tar creosote, coal-tar creosote solution, refined water gas tar, and water gas tar solution.

the 1,060,753 gallons of paving oil reported was less by 788,158 gallons than the 1920 consumption. The quantity of miscellaneous preservatives used in 1921 was greater by 38,210 gallons than was reported the year previous.

Wood Preservation Conserves the Forests

In 1909, the first year for which these statistics were gathered, 64 plants were in existence in the United States. That the industry has made rapid strides in a few short years is evident by the fact that in 1921 the number of plants increased to 135, or more than doubled. It is also apparent that wood preservation is an important means of combating forest depletion in this country, which through wasteful logging, fire, insect depredation and lack of adequate provision for future crops has assumed alarming proportions. It has been estimated that our original forests covered 822 million acres, representing a stand of at least 5,200 billion board feet of timber. Today only 463 million acres of forest land remains, supporting approximately 2,214 billion board feet of merchantable timber, or less than two-fifths of the country's original forest wealth. Only one-sixth of the original forest area now remains in virgin forest.

The total amount of wood used and destroyed annually in the United States amounts to approximately 26 billion cubic feet. This includes lumber and timber, crossties, piles, poles, cordwood, and the various other classes of primary products for which wood is the raw material used. It also takes into account 1½ billion feet destroyed each year by fire, insects, and disease. As compared with this enormous consumption it is estimated that but 6 billion cubic feet of wood is produced through annual growth. In other words, the standing timber of this country is being cut and destroyed nearly 4½ times as fast as it is being replaced by growth. At this rate of consumption it can readily be seen that unless vigorous action is taken at once looking to conservation and reforestation the remaining supply of timber will last but a comparatively short period of years.

Wood preservation constitutes an important item in forest conservation. In 1921 a little more than 200 million cubic feet of wood was subjected to preservative treatment. This is of course but a small part of the 26 billion cubic feet of wood that is used or destroyed annually. When we stop to consider, however, that the life of that which is treated is at least doubled, it can readily be seen what a tremendous saving in annual consumption could be effected if the practice of wood preservation were applied to all of the present annual consumption as would permit readily of treatment.

Wood, though possessing as wide a range of uses as any other raw material has always been handicapped by the fact that when exposed to conditions fostering decay it may last but a comparatively few years. One of its great advantages has in the past been its relative cheapness, but this advantage has been growing steadily less as the cost of wood has mounted higher and higher. To lay a section of railroad track, to timber a mine tunnel, or to construct a bridge with woods best suited to each class of project costs today several times more than it did twenty years ago. The gradually increasing difficulty in obtaining the more adaptable woods is the cause in no small part for the increased cost, as well as for the tendency to substitute poorer species, with only their cheapness and availability to recommend them. Thus the scarcity and resultant high price of the better woods and the exceedingly short life of the cheaper ones presented a problem, the solution of which, it may be said, gave birth to the wood-preserving industry.

The preservation of wood does more than merely prolong its life. It permits of the use of woods formerly considered unsuitable, but which when treated will last as long as any others. It gives the user a wider field of selection for his material and enables him to obtain satisfactory stock at a reduction in cost. It often permits the use of local species thus obviating high importation costs. It lessens the demand for the better species, thus making them available for exacting uses. In the final analysis, it makes renewals less frequent where wood is used and in this way reduces the drain on the forest.

The railroads, the arteries of commerce of the country, were first to realize the economy possible through the treatment of wood, and the wood-preserving industry has been built up largely on railroad material, principally ties. Today the preservative treatment of wood is standard practice with many other classes of commercial timber products such as piles, poles, paving blocks and construction timbers. The field, however, is so broad that it could readily be extended to include many others. Even on the farm and around the home much of the wood used for such purposes as fence posts, stable sills and other foundation timbers, door steps and porch framing, hog pens, chicken coops and similar uses, where the wood is in contact with the ground or exposed to the action of the elements, will respond readily to treatment. In the building of factories, docks, bridges, trestles and many other types of structures treated wood will prove economical in

TABLE 1.—TREATING PLANTS IN THE UNITED STATES, BY CLASSES AND TYPES 1921

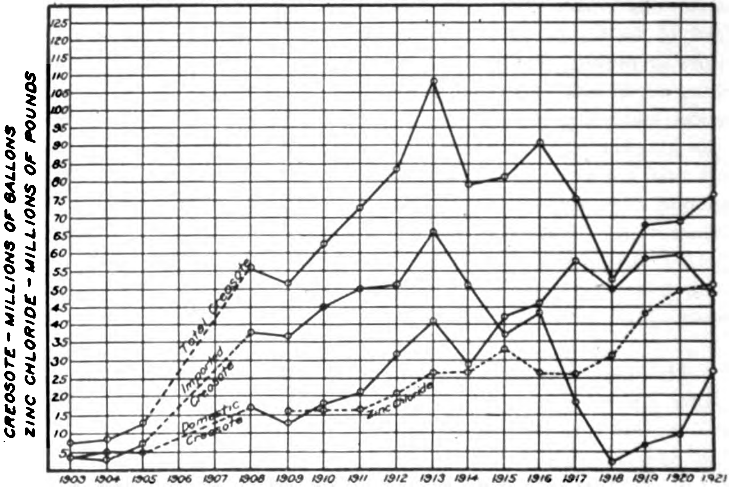
STATUS	COMMERCIAL PLANTS			RAILROAD PLANTS			PRIVATE PLANTS			Total
	Pressure	Non-pressure	Pressure and non-pressure	Pressure	Non-pressure	Pressure and non-pressure	Pressure	Non-pressure	Pressure and non-pressure	
Active (old)	63	7	2	26	0	0	4	11	1	114*
" (new)	4	1	0	2	0	0	1	0	0	8*
Idle	5	1	2	1	0	0	0	1	0	10
Abandoned	0	0	0	0	0	0	0	1	0	1
New (inactive)	0	0	0	0	0	0	0	2	0	2
Total	72	9	4	29	0	0	5	15	1	135*

*The total number of plants active was 122.

both initial cost and upkeep. The preservation of wood, therefore, through the reduction of the drain on the forests supplements in a most desirable way efforts to keep our forest lands fully productive.

PROGRESS OF WOOD PRESERVATION IN THE UNITED STATES

CONSUMPTION OF CREOSOTE AND ZINC CHLORIDE FROM 1903 TO 1921



Note. Figures for Creosote not available for years 1906 and 1907 nor for Zinc Chloride prior to 1909

OFFICE OF FOREST PRODUCTS
U.S. FOREST SERVICE

Source of Statistics

A total of 135 plants were in existence in the United States in 1921. Of these 122 were in active operation, or 10 more than reported in 1920. These plants supplied the data upon which this report is based. Table 1 shows by classes and types the number of plants which were active, idle or abandoned during the year.

As can be seen from Table 1, over 80 per cent of all treating plants in this country are of the pressure cylinder type. Though the data presented in this report is based largely upon the figures supplied by such plants, it also includes those obtained from non-pressure plants. Statistics are gathered, however, only from those plants which maintain regular treating plant equipment. No attempt is made to include brush treated material or that treated with temporary equipment in small amounts for special purposes. No doubt a considerable quantity of material is treated in this way, but because such instances are so numerous it would be extremely difficult to collect statistics concerning them.

Progress in Wood Preservation

The fact that 10 new plants started operation in 1921 evidences the continued growth of the industry. Further proof of this is the annual increase in the quantity of preservatives used and material treated. Each year one or two plants are abandoned, some are idle and several new ones are constructed. The number of plants in active operation, however, usually shows a net gain each year over the number that reported the year before. This is but another indication of growth, as is also the more general use of treated wood and wood preservatives by farmers, home builders and others representing the general public.

Consumption of Preservatives

Table 2 shows comparatively for the years 1909 to 1921 inclusive the number of treating plants in active operation and the amount of the various classes of preservatives which they used. Beginning with 1919 the domestic consumption was separated into the four classes of oils that are commonly used to preserve wood, namely, distillate coal-tar creosote, creosote coal-tar solution, refined water-gas tar, and water-gas tar solution. In these statistics this information is shown in the same way, the total consumption of the four classes of oils combined for 1921 being 48,270,972 gallons. Adding to this the 28,242,307 gallons of oil that was imported brings the total amount used up to 76,513,279 gallons, or more by 7,755,771 than was reported in 1920.

A total of 1,060,753 gallons of paving oil was consumed by the treating plants of this country in 1921. This was 788,158 gallons less than was used the year previous. The reported consumption of miscellaneous preservatives increased from 1,772,084 gallons in 1920 to 1,810,294 gallons in 1921. As was the case during the previous year, the increased use of this class of preservatives was due largely to the employment by several of the treating plants of large quantities of crude oil and coke oven tar to dilute creosote oil.

The largest quantity of zinc chloride ever reported by the wood preserving industry in this country was used in 1921. The total consumption amounted to 51,375,360 pounds, representing an increase over the 1920 figure of 1,657,431 pounds. Of the total quantity consumed 26,267,357 pounds was reported in 50 per cent solution and 25,108,003 pounds as fused.

TABLE 2.—CONSUMPTION OF WOOD PRESERVATIVES BY THE TREATING PLANTS OF THE UNITED STATES—1909-1921

Year	CREOSOTE							Paving oil	Zinc chloride	Other preservatives
	Number of active plants	Distillate coal-tar creosote	Creosote coal-tar solution	Refined water-gas tar	Water-gas tar solution	Imported	Total			
		Gallons	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Gallons*	*Pounds*	*Gallons*
1909	64	(a)	(a)	(a)	(a)	37,569,041	51,426,212	(a)	16,215,107	(b)
1910	71	(a)	(a)	(a)	(a)	45,081,916	63,266,271	(a)	16,802,532	2.333,707
1911	80	(a)	(a)	(a)	(a)	51,516,706	73,027,335	(a)	16,359,797	1,000,000
1912	84	(a)	(a)	(a)	(a)	52,531,295	83,600,490	(a)	20,751,711	3,072,462
1913	93	(a)	(a)	(a)	(a)	66,673,192	108,873,359	(a)	26,466,808	3,885,738
1914	94	(a)	(a)	(a)	(a)	51,307,786	79,384,606	9,429,444	27,212,259	2.486,637
1915	102	(a)	(a)	(a)	(a)	37,501,007	80,859,442	3,205,593	33,269,604	1,693,544
1916	117	(a)	(a)	(a)	(a)	43,649,931	90,404,749	5,675,095	26,746,577	583,754
1917	115	(a)	(a)	(a)	(a)	18,259,141	75,541,737	7,579,819	26,444,689	137,361
1918	107	(a)	(a)	(a)	(a)	2,165,736	52,776,886	4,057,862	31,101,111	28,013
1919	108	24,286,851	31,292,661	1,148,084	2.334,727	6,493,974	65,556,247	2.411,592	43,483,134	103,011
1920	115	25,483,230	27.921,614	1,377,702	4.399,282	9,575,680	68,757,508	1,848,911	49,717,929	1,772,084
1921	122	19,460.500	23,283,046	3,135,610	2.391,816	28,242,307	76,513,279	1,060,753	51,375,360	1,810,294

(a) Statistics for years 1909 to 1918, inclusive, not separated.
(b) Statistics not available.

TABLE 3.—PRICES PAID FOR PRESERVATIVES—1921

Region	Years	Distillate coal-tar creosote	Creosote coal-tar solution	Refined water-gas tar	Water-gas tar solution	Zinc chloride 50 per cent solution	Zinc chloride fused
		Per gallon	*Per gallon*	*Per gallon*	*Per gallon*	*Per gallon*	*Per pound*
Atlantic Coast region	1920	$0.15 to .25	$0.11 to .20	$0.09 to .24	$0.08 to .15	$0,04 to .0433	$0.08 to .0825
	1921	.14 " .23	.08 " .18	.10 " .325	.12 " .13	.04 " .045	.08 " .085
Southern Coast region	1920	.10 " .295	.109 " .20	.10 " .20	.15	.04 " .0415	.0729 " .09
	1921	.10 " .35	.09 " .18	....	....	.04	.0758 " .099
Interior Eastern region	1920	.098 " .45	.093 " .25	.0631 " .10	.08 to .15	.0343 to .0415	.068 " .1085
	1921	.14 " .325	.09 " .18	.0837 " .0925	....	.035 " .04	.07 " .08
Interior Western region	1920	.121 " .50	.161 " .29	....	....	.0417	.079 " .0942
	1921	.176 " .49	.121 " .29	....	....	....	.073 " .0867
Pacific Coast region	1920	.244 " .288	.23 " .35	....	....	.0425 to .043	.075 " .08
	1921	.24 " .32	.23 " .416	....	....	.039 " .545	.0857

Table 3 shows the prices paid for preservatives during the year, and it can be seen that they cover rather a wide range, especially those paid for the four classes of oils. In some regions oil prices almost reached pre-war normals, while in others they were exceedingly high. The prices paid for zinc chloride in 1921 show a slight increase over those of 1920 in all regions.

The importation of foreign oil to the United States in 1921 amounted to 28,242,307 gallons, nearly three times that which was obtained abroad the year before. This large increase was probably due to existing world conditions, the wood-preserving plants in this country doubtless taking advantage of the rates of exchange current during the year and placing orders abroad. Table 4 shows the actual amount of creosote oil that was imported into this country during 1920 and 1921. The total for 1921 was 36,574,728 gallons, while the quantity reported as having been used by the treating plants during the year was 28,242,307 gallons. The fact that some of the plants had on hand at the close of 1921 some of the oil purchased during that year accounts for a large part of the difference in the two figures. The balance was consumed no doubt by purchasers of small quantities of oil for use in the brush treatment of wood and by manufacturers of shingle stains or proprietary preservatives.

TABLE 4.—MONTHLY IMPORTS OF FOREIGN CREOSOTE—1920–1921*

Month	1920	1921
	Gallons	*Gallons*
January	3,002,222	5,023,682
February	45,295	27,732
March	236,942	5,080,204
April	962,664	3.120,836
May	42,222	33,406
June	939,878	1.305,947
July	988,173	2,692,786
August	3,529,697	3,909,368
September	1,044,252	3,556,110
October	5,226,884	7,649,791
November	2,347,631	1,542,111
December	51,292	2.732,805
Total	18,427,152	36,574,728

*Figures of Bureau of Foreign and Domestic Commerce.

Table 5 presents figures showing comparatively the quantities of foreign and domestic creosote consumed by the treating plants of this country each year from 1909 to 1921 inclusive. As indicated in the table referred to 28,242,307 gallons of creosote was reported by the treating plants in 1921 as having been obtained from abroad. Of this quantity 21,051,139 gallons were imported from England and 7,191,168 gallons were obtained from Germany.

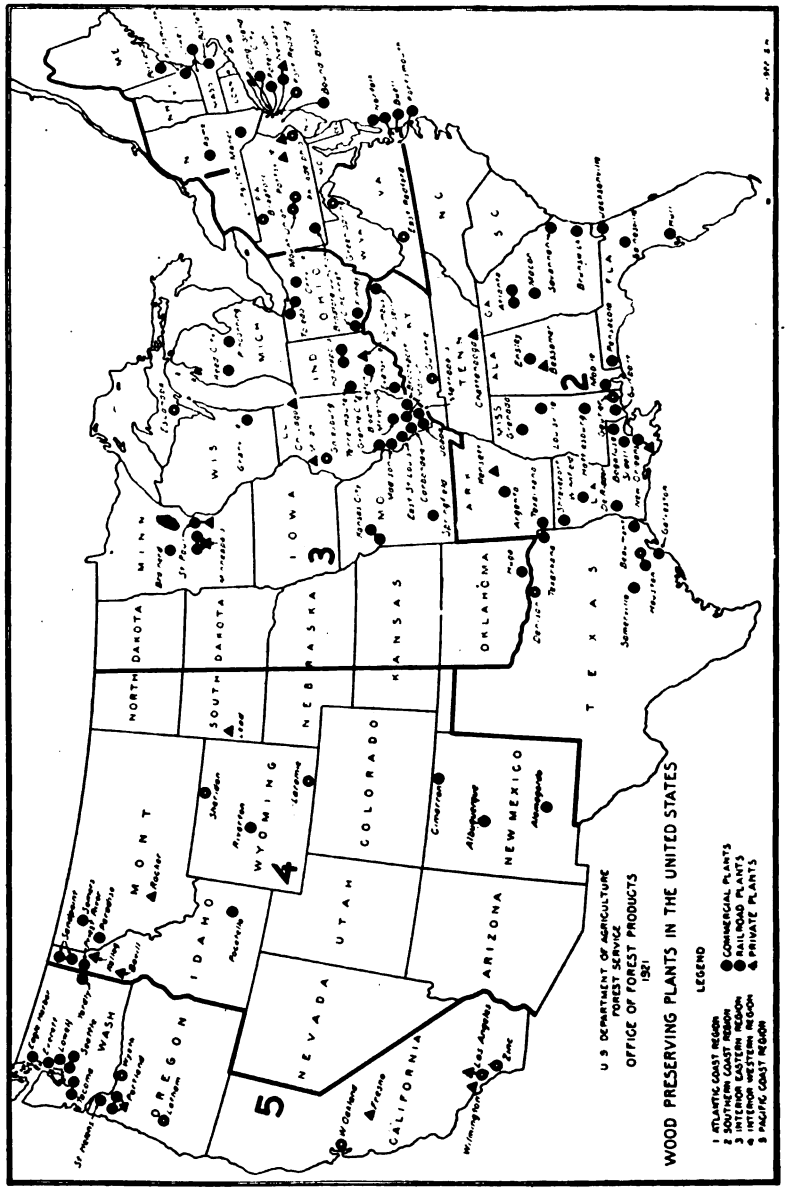
TABLE 5.—RELATIVE QUANTITY OF DOMESTIC AND IMPORTED CREOSOTE USED BY THE TREATING PLANTS OF THE UNITED STATES, 1909 TO 1921

Year	Domestic creosote	Per cent of total	Imported creosote	Per cent of total	Total creosote used
	Gallons		*Gallons*		*Gallons*
1909	13,862,171	27	37,569,041	73	51,426,212
1910	18,184,355	29	45,081,916	71	63,266,271
1911	21,510,629	29	51,516,706	71	73,027,335
1912	31,135,195	37	52,531,295	63	83,666,490
1913	41,700 167	38	66,673,192	62	108,373,359
1914	28,026,870	35	51,307,736	65	79,334,606
1915	43,358,435 (a)	54	37,501,007	46	80,859,442
1916	46,754,818 (b)	52	43,649,931	48	90,404,749
1917	57,282,596 (c)	76	18,259,141	24	75,541,737
1918	50,610,650 (d)	96	2,165,736	4	52,776,386
1919	59,062,273 (e)	90	6,493,974	10	66,556,247
1920	59,181,828 (f)	86	9,575,660	14	68,757,508
1921	48,270,972 (g)	63	28,242,307	37	76,513,279

(a) 41,333,890 gallons coal-tar creosote and 2.024.545 gallons water-gas tar.
(b) 45,318,735 " " " " 1,436.083 " " "
(c) 54,305,204 " " " " 2,977,392 " " "
(d) 47,787,998 " " " " 2,822,652 " " "
(e) 24,286,851 gallons distillate coal-tar creosote; 31,292,661 gallons creosote coal-tar solution; 1,148,034 gallons refined water-gas tar; and 2,334,727 gallons water-gas tar solution.
(f) 25,483,230 gallons distillate coal-tar creosote; 27,921,614 gallons creosote coal-tar solution; 1.377.702 gallons refined water-gas tar; and 4,399,282 gallons water-gas tar solution.
(g) 19,460,500 gallons distillate coal-tar creosote; 23.283,046 gallons creosote coal-tar solution; 3,135,610 gallons refined water-gas tar; and 2,391,816 gallons water-gas tar solution.

Preservatives Used and Material Treated by Regions

In the compilation of these statistics the plan followed in past years of dividing the country into five regions was again adopted. These regions are clearly indicated on the accompanying map,



WOOD PRESERVING PLANTS IN THE UNITED STATES

U S DEPARTMENT OF AGRICULTURE
FOREST SERVICE
OFFICE OF FOREST PRODUCTS
1921

TABLE 6.—PRESERVATIVES USED AND MATERIAL TREATED IN THE UNITED STATES IN 1920 AND 1921

Region	Year	Number of active plants	CREOSOTE			Paving oil	Other preservatives	CROSSTIES		Piles	Poles	Wood blocks	Construction timbers	Cross-arms	Miscellaneous
			Domestic (a)	Imported	Zinc chloride			Hewed	Sawed						
			Gallons	*Gallons*	*Pounds*	*Gallons*	*Gallons*	*Number*	*Number*	*Lin. ft.*	*No.*	*Sq. yd.*	*Bd. ft.*	*No.*	*Bd. ft.*
Atlantic Coast	1920	22	17,269,246	840,000	1,804,339	....	160,250	4,036,877	1,638,864	2,589,375	18,472	184,176	22,730,703	25,475	2,676,668
	1921	23	12,669,436	8,368,863	2,238,899	....	53,800	6,247,676	2,179,933	456,276	8.577	305,132	22,500,032	60,355	908,108
Southern Coast	1920	31	24,476,974	5,269,270	18,957,246	298,911	464.703	13,793,332	2,109,461	6,259,484	140,018	629.982	79,513,756	382,699	4,905,704
	1921	34	17,276,561	16,014,477	15,689,182	429,753	305,223	11,849,055	5,862.973	5,638,592	244,709	791,734	81,079,195	105,647	4,551,982
Interior Eastern	1920	31	14,019,917	173,439	20,313.143	1,550,000	497,575	13,373,127	3,842,155	298,556	262,297	1,725.842	22,176,787	105.768	4,957,914
	1921	35	15,354,462	2,059,034	22,616,255	640,000	699,703	14,383,682	6,051,159	838,894	238,053	1,251,417	24,602,316	1,248	1,942,218
Interior Western	1920	13	1,770,286	21,649	4,946,467	....	646,271	1,996,290	1,515,686	185,320	102,483	1,670	10,447,261	268	119,163
	1921	15	1,578,092	194,137	6,704,545	....	733,011	2,240,913	2,592,656	8,948	66,148	600	6,214,702	52	103,441
Pacific Coast	1920	15	1,645,405	3,271,322	3,696,734	....	3,285	100,713	2,531,027	2.633,177	62,511	26,486	4,881,232	....	2,204,830
	1921	15	1,392,421	1,605,796	4,126,479	....	18,557	1,098,605	2,876,863	1,325,809	70,198	14,128	8,124,249	8,101	2,549,445
Total	1920	112	59,181,828	9,575,680	49,717,929	1.848,911	1,772,084	33.300,339	11,687,193	11,965,912	585,781	2,568,157	139,749,738	514,210	14,864,274
	1921	122	48,270,972	28,242,307	51,375,360	1,060,754	1,810,294	35,819,931	19,563,584	8,268,519	622,685	2.363,011	142,520,494	175,403	10,055,189

(a) Includes distillate coal-tar creosote, creosote coal-tar solution, refined water-gas tar, and water-gas tar solution.

and were selected originally because the area embraced in them conforms closely to the principal forest regions of the country. Table 6 shows comparatively for 1920 and 1921 not only the quantity of preservatives consumed in the various regions but also the amount of the different classes of material treated by plants included in each.

Atlantic Coast Region

In the Atlantic Coast Region in 1921 a total of 23 plants, or one more than reported in 1920, were in active operation. They consumed 21,038,299 gallons of creosote and occupied second place in the consumption of oil. Of the quantity used 12,669,436 gallons were of domestic manufacture and 8,368 863 gallons were of foreign importation. These plants also used 2,238,899 pounds of zinc chloride and 53,800 gallons of miscellaneous preservatives in the preservative treatment of wood during the year.

The plants of this region treated 6,247,676 hewed and 2,179,933 sawed crossties, or a total of 8,427,609, the third largest quantity reported by any of the five regions.

In the Atlantic Coast Region in 1921 there were subjected to treatment 8,577 poles and 456,276 linear feet of piles, as compared with 18,472 of the former and 2,589,375 linear feet of the latter the year before.

In 1921 the region ranked third in the treatment of construction timbers with a total of 22,500,032 board feet or 230,671 board feet less than was reported in 1920.

In addition to the material mentioned above, the plants of this region also treated 305,132 square yards of wood blocks, 60,355 cross arms and 908,103 board feet of miscellaneous lumber.

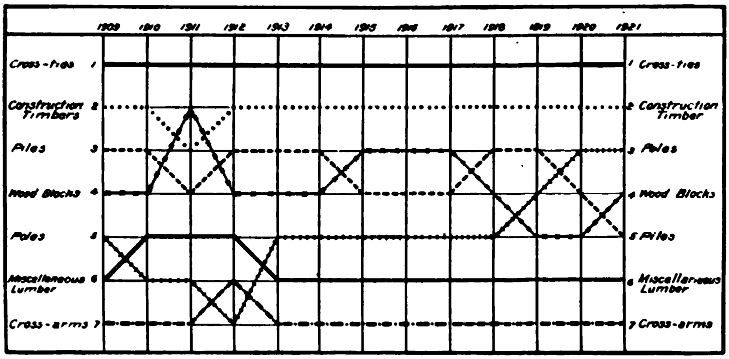
Southern Coast Region

The plants of this region have always been the leaders in the consumption of creosote oil. In 1921 the 34 plants that were active again ranked first in this respect, their total consumption of this preservative being 33,291,038 gallons, or nearly 50 per cent of the total quantity used by the plants throughout the entire country. Of the quantity used 17,276,561 gallons were obtained from manufacturers in this country while 16,014,477 gallons were imported, the latter constituting nearly double the quantity of foreign oil reported by any of the other regions. This region ranked second in the consumption of both zinc chloride and paving oil with a total of 15, 689, 182 pounds of the former and 420,753 gallons of the latter. There were also used by this group of plants 305,223 gallons of miscellaneous preservatives.

The plants of the Southern Coast Region occupied second place in the treatment of crossties, the total being 17,712,028. Of these 11,849,055 were hewed and 5,862,973 were sawed.

The region also ranked second in the treatment of wood blocks, the total quantity reported being 791,734 square yards, or 161,752 square yards more than were treated in the region the year before.

RELATIVE RANK OF THE SEVEN CLASSES OF MATERIAL TREATED 1909-1921.



In the treatment of the five other classes of material, including piles, poles, cross arms, miscellaneous material and construction timbers the Southern Coast Region took the lead over all others. The quantity of construction timbers treated was 81,079,195 board feet, or considerably more than half of the total of 142,520,494 board feet reported by the plants of all five regions.

Interior Eastern Region

In 1921 there were 35 plants actively engaged in the treatment of wood in this region, or 4 more than reported in 1920. They consumed 17,413,496 gallons of creosote, the third largest quantity reported, of which 15,354,462 gallons were domestic and 2,059,034 gallons of foreign manufacture. The plants of the region lead in the consumption of zinc chloride with a total of 22,616,255 pounds. They also ranked first in the use of paving oil, with a consumption of 640,000 gallons, while in the matter of miscellaneous preservatives they occupied second place with 669,703 gallons.

The plants of the Interior Eastern Region took first place in the treatment of crossties. The number reported was 20,434,841, consisting of 14,383,682 hewed and 6,051,159 sawed ties.

In the treatment of piles and poles the plants embraced in this region ranked third and second respectively with 838,894 linear feet of the former and 233,053 of the latter. These plants took first place in the treatment of wood blocks with 1,251,417 square yards, while the quantity of construction timbers which they impregnated with preservatives was 24,602,316 board feet, or the second largest quantity reported.

In addition to the material already enumerated there were reported by the plants of the Interior Eastern Region in 1921 a total of 1,248 cross arms and 1,942,218 board feet of miscellaneous lumber.

Interior Western Region

The plants in active operation in this region in 1921 numbered 15, or 2 more than reported the year previous. They used a total of 1,772,229 gallons of creosote, or the smallest quantity reported by any of the five regions. Of the amount consumed 1,578,092 gallons was obtained from manufacturers in this country while 194,137 gallons was procured abroad. The plants, however, occupied third place in the consumption of zinc chloride, the quantity reported being 6,704,545 pounds, or 1,758,078 pounds more than was used in 1920. In the use of miscellaneous preservatives this group of plants ranked first with a total consumption of 733,011 gallons. They used no paving oil either in 1921 or 1920.

A total of 4,833,569 crossties were treated in this region during the period covered by this report, which represents an increase over the number reported in 1920 of 1,321,593. Of the total quantity run through the treating cylinders 2,240,913 were hewed and 2,592,656 were sawed. These plants treated only 8,948 linear feet of piles in 1921 as compared with 185,320 linear feet in 1920, while the number of poles subjected to treatment was less than the year before by 36,335.

The plants of this region also reported the treatment of 600 square yards of wood blocks, 6,214,702 board feet of construction timbers, 52 cross arms and 103,441 board feet of miscellaneous lumber.

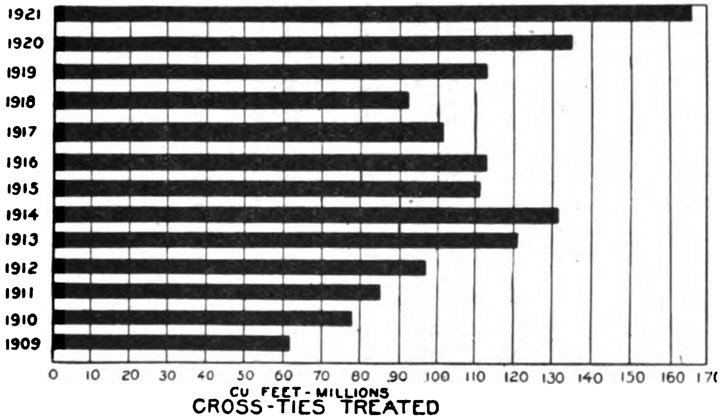
Pacific Coast Region

Fifteen plants, the same number that reported in 1920, were active in this region in 1921. They consumed 2,998,217 gallons of creosote, 4,126,479 pounds of zinc chloride and 18,557 gallons of miscellaneous preservatives. Of the creosote used 1,392,421 gallons were of domestic manufacture and 1,605,796 gallons were of foreign importation.

In 1921 the plants of this region treated 2,876,863 sawed ties and 1,098,605 hewed ties, the latter figure representing an increase of nearly a million ties over the quantity of hewed ties reported the year before.

The quantity of piling that was run through the cylinders of this group of plants during the year covered by this report was 1,325,809 linear feet, while the number of poles treated was 70,198.

These plants also impregnated with preservatives 14,128 square yards of wood blocks, 8,124,249 board feet of construction timbers, 8,101 cross arms and 2,549,445 board feet of miscellaneous lumber.



CROSS-TIES TREATED

Preservation of Crossties

As previously mentioned in this report, the wood-preserving industry in this country has been built up largely upon the treatment of railroad timber, especially crossties. That this class of material still contributes heavily to the total quantity of wood treated in the United States each year is evidenced by the fact that of the 201,643,228 cubic feet of wood treated in 1921 over 75 per cent, or 166,150,545 cubic feet were crossties. The total number of ties treated during the year was 55,383,515, of which 35,819,931 were hewed and 19,563,584 were sawed.

The crossties treated in the largest quantity were those of

TABLE 7.—CROSSTIES TREATED, BY KINDS OF WOOD AND KINDS OF PRESERVATIVES—1921

Preservative	Yellow pine	Oak	Douglas fir	Beech	Maple	Gum	Birch	Tamarack	Western pine	Hemlock	Elm	All other	Total
Creosote [1]	9,116,536	5,804,372	1,171,637	1,878,705	1,119,105	1,122,342	904,495	225,376	32,582	109,000	269,287	293,029	22,046,466
Zinc chloride.....	11,668,189	5,810,415	3,778,610	1,674,533	1,231,922	1,437,242	749,544	1,392,487	1,303,864	1,133,701	1,797	83,643	30,265,947
Zinc chloride and creosote [2] ..	726,994	1,223,370	....	627,923	331,768	....	25,500	....	....	92,074	....	33,605	3,061,234
Miscellaneous....	....	....	9,868	....	....	....	....	....	....	....	....	....	9,868
Total..........	21,511,719	12,838,157	4,960,116	4,181,161	2,682,795	2,559,584	1,679,539	1,617,863	1,336,446	1,334,775	271,084	410,277	55,383,515
Per cent of total..	38.8	23.2	9.0	7.6	4.9	4.6	3.0	2.9	2.4	2.4	0.5	0.7	100.0

(1) Includes distillate coal-tar creosote, creosote coal-tar solution, refined water-gas tar, and water-gas tar solution.

(2) " " " " " " " " " " " " " in mixture with zinc chloride.

yellow pine, the total number reported being 21,511,719. Oak ties ranked second with 12,838,157 and Douglas fir ties were third with 4,960,115. Other ties treated in any quantity were those of western pine, beech, gum, tamarack, maple, birch, elm and hemlock. The number of ties of the different species of wood reported, the percentage of the total which each represents, and the number treated with the various preservatives used are shown in Table 7.

Table 8 shows the number of ties treated in 1921 by classes and types. As can be seen from this table, the bulk of the ties treated are those intended for use on steam railroads. Of the total number of ties of this type that were subjected to preservative treatment during the year, 2,528,177 were adzed, 1,173,810 were bored, 8,091,272 were both adzed and bored and 42,434,212 were neither adzed nor bored. Of the ties intended for use on electric roads 50,965 were adzed, 2,812 were bored, none were both adzed and bored, and 1,102,267 were neither adzed or bored.

TABLE 8.—CROSSTIES TREATED, BY CLASSES AND TYPES, IN 1921

Class of tie	Adzed	Bored	Adzed and bored	Not adzed or bored	Total
Steam railroad............	2,528,177	1,173,819	8,091,272	42,434,212	54,227,471
Electric railroad..........	50,965	2,812	....	1,102,267	1,156,044
Total..................	2,579,142	1,176,622	8,091,272	43,536,479	55,383,515

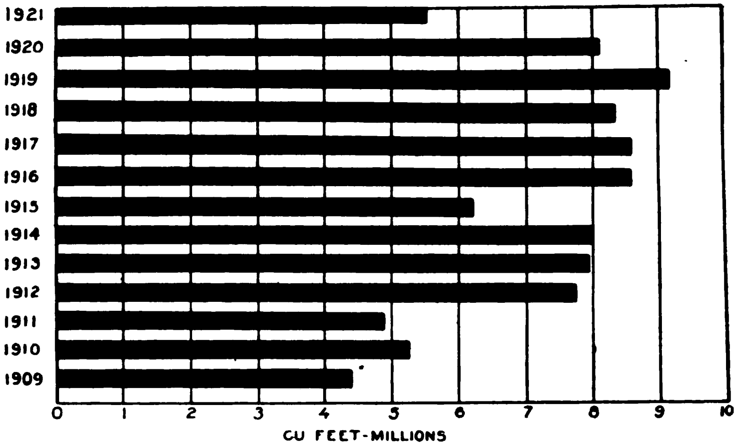
A total of 22,046,466 crossties were treated with creosote in 1921 and 30,265,947 with zinc chloride. The number of ties impregnated with the zinc-creosote emulsion was 3,061,234, while 9,868 were subjected to treatment with miscellaneous preservatives.

In treating ties with creosote an average absorption of 7.21 pounds per cubic foot was obtained. Where zinc chloride was used the average quantity of preservative that was forced into the wood was 0.48 pound per cubic foot. With the use of the zinc-creosote emulsion the injection amounted to 0.49 pound of zinc and 2.75 pounds of creosote. Practically all of the wood-preserving processes used commercially were employed in the treatment of crossties.

The average life of an untreated crosstie is estimated at 7½ years. When treated its average life is increased to about 15 years. Approximately 100 million ties are used annually by the railroads of the country and about half of these are treated. If all were subjected to treatment, future yearly requirements would be reduced 25 per cent, which on the basis of 30 board feet per tie would mean an annual saving of 750 million board feet of wood.

Preservation of Piles

During 1921 a total of 8,268,519 linear feet of piles were reported treated by the plants throughout the country. This represents a decrease of 3,697,393 linear feet, or 30 per cent from the number subjected to treatment in 1920. Although piles treated were principally of southern yellow pine and Douglas fir, a small quantity of cypress, oak and western red cedar were also reported. Of the total quantity of piles treated 5,638,592 linear feet, or nearly 70 per cent were reported by the plants of the Southern Coast Region.

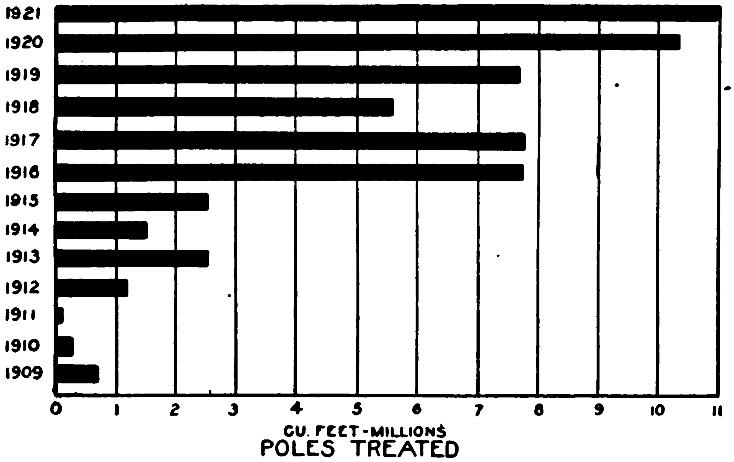


PILES TREATED

The bulk of the piles reported were impregnated with creosote. Approximately 100,000 linear feet were, however, treated with creosote in mixture with zinc chloride, and a very few, less than 500 linear feet, were preserved with zinc chloride alone. The use of zinc chloride in the treatment of piling constitutes a new departure in wood preservation. Since this salt has a tendency to leach out of the wood under the action of water, it is rarely employed as a preservative for piling.

In the treatment of piles with creosote an average of 13.20 pounds of oil per cubic foot were forced into the wood. For those piles treated with the zinc-creosote emulsion the average absorption per cubic foot was 0.49 pound of the former and 3.15 pounds of the latter. Those piles that were subjected to treatment with zinc chloride alone carried the heavy injection of 0.89 pound per cubic foot.

Our forests are called upon annually to furnish approximately 50 million linear feet of piles, of which not more than one-fifth are subjected to preservative treatment. Untreated piles on an average fail from decay and the attacks of marine borers in sea water in from 1 to 4 years, and last up to a maximum of perhaps 12 to 15 years when used on land. Piles that have been given a full pressure treatment of creosote may give from 15 to 30 years service, or even more depending upon the use to which they are put. Since most piles are of saw timber size, some idea can be obtained of the saving in wood possible if all piles are treated.



Preservation of Poles

In 1921 a total of 622,685 poles were subjected to preservative treatment. Of this number 362,947 were given butt treatment only, while 259,738 received full length pressure treatment. The number reported for the year exceeded the 585,781 treated in 1920 by 36,904. As previously mentioned, these statistics are based only on material treated at regular pressure and open tank plants and do not therefore include brush treated poles or those subjected to treatment in small quantities with temporary equipment.

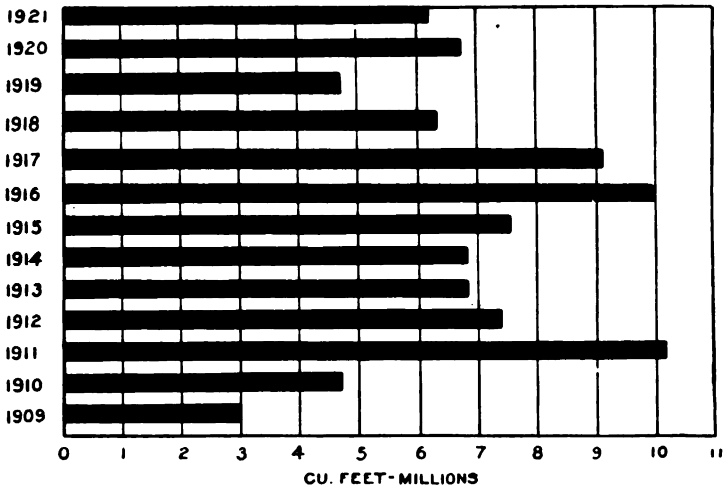
The principal species of wood represented among the poles reported were, in the order of their importance according to quantity treated, cedar, southern yellow pine, chestnut and Douglas fir.

All of the poles reported in 1921 were treated with creosote. The full cell, Lowry and Rueping were the pressure processes employed, in connection with which an average absorption of 9.96 pounds per cubic foot was obtained. In addition, the open tank, or nonpressure process, was employed to a considerable extent in treating poles during the year.

Approximately 4¼ million poles are required each year by the principal classes of consumers throughout the country. Since each pole produced usually represents the cutting down of one tree, it follows that in the production of the country's pole requirements alone close to 4¼ million trees are removed from the forests each year. The average number of poles treated annually, based on figures compiled for the last 8 years, is about 275,000, or less than 7 per cent of the total number used each year. Thoroughly treated poles will give at least double the life of untreated poles, and here again a large amount of timber could be conserved if all poles were given preservative treatment. The steady increase in the use of treated poles during the last few years is encouraging.

Preservation of Wood Blocks

The plants of this country treated 2,363,011 square yards of wood blocks during 1921, or approximately 200,000 square yards



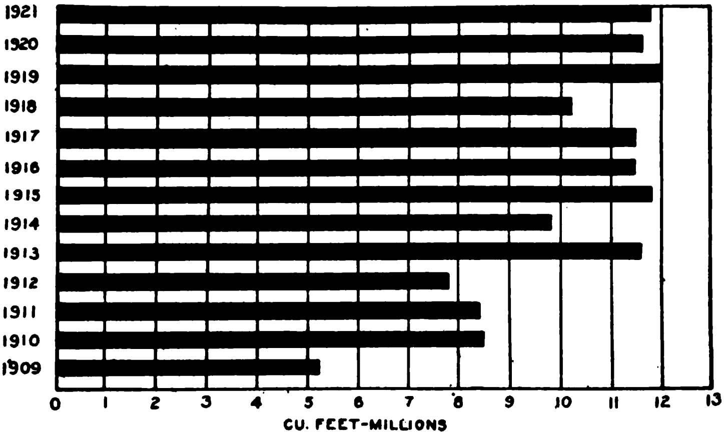
WOOD BLOCKS TREATED

less than were reported the year before. Of the total quantity treated 1,209,895 square yards were intended for use in outside paving and 1,153,116 square yards for inside flooring. With the exception of 15,025 square yards of Douglas fir blocks the total quantity reported were of yellow pine.

Creosote and paving oil were the two preservatives used in the treatment of wood blocks.

Preservation of Construction Timbers

Construction timbers include bridge and dock timbers, switch ties and similar heavy material required for structural purposes. The quantity of material of this kind reported as treated in 1921 by the plants of the United States was 142,520,494 board feet. The plants of the Southern Coast Region ranked first in the treatment of this class of material with a total of 81,079,195 board feet. Those of the Interior Eastern Region came second with 24,602,316 board feet, and the third largest quantity, or 22,500,032 board feet, was treated by the plants of the Atlantic Coast Region.

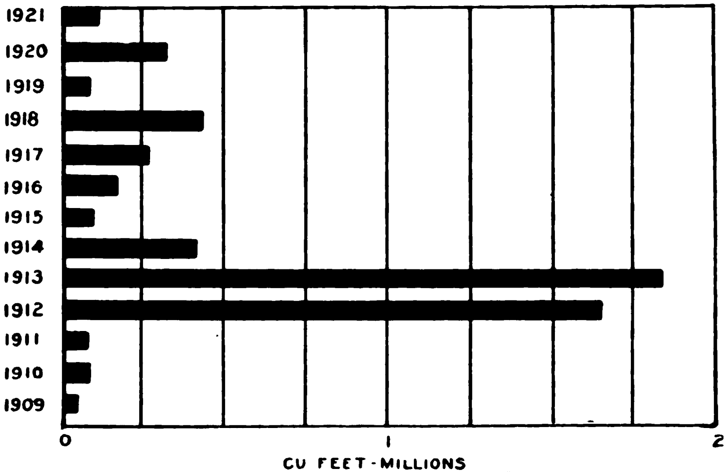


CONSTRUCTION TIMBER TREATED

Practically all of the wood-preserving processes used commercially were employed in the treatment of construction timbers. Where creosote was the preservative used an average injection of 10.21 pounds per cubic foot was obtained. For zinc chloride it was 0.496 pound per cubic foot. In the case of the zinc-creosote mixture 0.50 pound of zinc and 5.10 pounds of creosote were forced into the wood per cubic foot.

Preservation of Cross Arms

Cross arms to the number of 175,403 were reported treated in 1921. This represents a decrease of 338,807 from the 514,210 reported in 1920. Of the total number treated 105,647 or 60 per cent were reported by the plants of the Southern Coast Region. Creosote, the only preservative used, was forced into the wood by the full cell and Rueping processes, and the average absorption was 9.20 pounds per cubic foot.



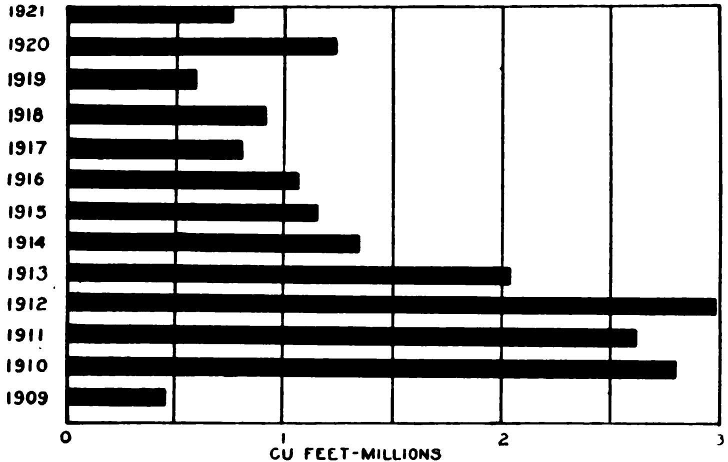
CROSS-ARMS TREATED

Preservation of Miscellaneous Lumber

A wide range of wooden commodities is covered by this classification, including pipe staves, electric wire conduit, shingles, posts, pole butts, anchor slugs, pole steps, crossing plank, mine props and lagging, tie plugs and miscellaneous lumber and dimension material. The total quantity of such material reported as treated in 1921 was 10,055,189 board feet, or less by 4,809,085 board feet, than was reported the year previous.

Creosote, zinc chloride and creosote in mixture, and zinc chloride were the preservatives used in treating miscellaneous lumber. With the first mentioned an average absorption of 9.14 pounds per cubic foot was obtained, with the zinc-creosote emulsion it was 0.49 pound of the zinc and 2.91 pounds of the creosote, and with the straight zinc an average of 0.483 pound per cubic foot was forced into the wood. The Burnett, Card, full cell, Lowry, Rueping and open tank processes were used.

Conditions as they exist in mine tunnels and other underground workings are most advantageous for rapid decay in timber used for such purposes as lagging, props and brattice. A very few of the mining companies appreciate the saving possible through the use of treated wood. Most of them give the wood which they use no treatment at all. The annual consumption of round mine timbers alone is around 250 to 300 million cubic feet, and untreated they require renewing every two or three years. When treated their life is increased several hundred per cent. If all of this timber which is used in permanent locations were treated another big forward step in the economical ultilization of our forest resources would be taken.



LUMBER AND MISCELLANEOUS TREATED

Treated shingles, even of timber not naturally resistent to decay, should give from 30 to 45 years service. Untreated they have a life of from 10 to 15 years. The total quantity of wood consumed annually in the manufacture of this class of product is approximately 900 million board feet, and the quantity treated is so small as to be almost negligible. If the entire output of shingles were subjected to preservative treatment, it is at once apparent that a large saving in timber would be effected from this source alone.

Table 9 shows in cubic feet the total quantity of the different classes of material reported treated with the various kinds of preservatives used for the years 1909 to 1921 inclusive.

TABLE 9.—COMPARATIVE STATEMENT OF MATERIAL TREATED IN THE UNITED STATES—1909 to 1921

Preservative	Year	CUBIC FEET							
		Cross-Ties	Piles	Poles	Wood Blocks	Cross Arms	Construction Timbers	Miscellaneous Lumber	Total Material Treated
Creosote	1909	29,830,080	4,421,726	659,664	2,994,290	41,764	4,902,311	417,787	43,267,622
	1910	44,525,229	5,219,254	255,597	4,692,453	88,069	7,801,272	2,687,713	65,269,587
	1911	49,532,163	4,937,363	106,213	10,145,724	71,961	7,417,105	2,499,995	74,710,524
	1912	57,461,515	7,624,939	1,169,981	7,091,658	1,643,128	6,892,493	2,841,195	84,724,909
	1913	75,998,307	7,630,328	2,367,769	6,810,308	1,813,010	10,308,883	1,853,993	106,782,598
	1914	67,774,329	7,804,657	1,188,511	3,127,506	395,403	8,889,158	1,348,566	90,028,180
	1915	51,281,207	6,288,238	2,336,318	6,064,758	87,373	9,264,164	881,028	76,153,086
	1916	62,576,403	8,524,680	6,308,954	7,206,953	178,210	9,521,609	691,870	95,002,679
	1917	48,685,554	8,493,715	5,930,559	4,610,427	239,764	7,830,673	706,084	76,496,776
	1918	34,638,147	7,620,974	4,540,620	4,825,766	210,908	7,606,153	707,294	60,149,857
	1919	44,938,215	9,151,972	6,649,491	3,372,828	75,310	9,220,880	553,750	73,962,446
	1920	49,114,551	8,013,192	10,309,746	6,741,410	818,707	9,054,413	1,139,307	75,691,826
	1921	66,139,398	5,528,275	10,906,157	6,202,904	103,715	9,052,679	663,183	98,601,811
Zinc Chloride	1909	24,153,162	(a)	(a)	(a)	(a)	320,891	2,333	24,476,386
	1910	27,587,583	(a)	(a)	(a)	(a)	541,514	71,060	28,200,157
	1911	28,337,883	(a)	(a)	(a)	(a)	1,043,851	119,931	29,501,665
	1912	28,532,874	(a)	18,246	(a)	(a)	259,972	20,092	28,881,184
	1913	36,051,816	(a)	47,996	(a)	(a)	585,756	7,670	36,693,288
	1914	50,020,755	(a)	(b)	(a)	(a)	1,317,925	4,355	51,343,035
	1915	53,457,852	4,726	(a)	(a)	(a)	2,406,150	275,279	56,144,007
	1916	43,859,028	859	164	(a)	(a)	1,526,881	346,047	45,732,979
	1917	44,529,954	7,093	45,788	10,421	(a)	2,127,872	5,070	46,726,198
	1918	51,166,146	57,845	(a)	13,989	(a)	2,337,169	30,790	53,605,889
	1919	58,912,323	2,919	(a)	(a)	(a)	2,164,007	63,987	61,143,286
	1920	87,398,160	(a)	(a)	(a)	(a)	1,823,437	94,151	89,315,748
	1921	90,797,841	298	(a)	(a)	(a)	2,738,292	67,835	93,604,266
Zinc-Creosote	1909	8,095,794	(a)	(a)	(a)	(a)	62,918	43,699	8,202,411
	1910	6,354,219	38,892	(a)	(a)	(a)	181,143	30,646	6,604,400
	1911	7,312,874	(b)	(a)	(a)	(a)	(b)	(b)	7,312,874
	1912	8,214,303	97,874	(a)	(a)	(a)	560,613	99,367	8,972,157
	1913	6,938,838	327,594	(a)	(a)	(a)	758,989	53,628	8,079,049
	1914	5,868,834	(a)	(a)	(a)	(a)	140,718	(b)	6,009,552
	1915	6,548,136	2,320	110,220	(a)	(a)	40,396	4,822	6,705,814
	1916	5,935,242	887	53,938	(a)	(a)	359,428	(a)	6,349,440
	1917	6,482,046	(a)	(a)	(a)	(a)	1,102,685	847	7,585,528
	1918	6,023,334	167,438	12,800	76,393	209,927	164,813	125,327	6,779,582
	1919	8,850,222	14,059	(a)	(a)	(a)	562,403	58,390	9,485,063
	1920	7,414,866	79,354	(a)	(a)	(a)	484,128	5,231	7,983,574
	1921	9,183,702	61,886	(a)	(a)	(a)	48,287	2,499	9,295,824

TABLE 9.—COMPARATIVE STATEMENT OF MATERIAL TREATED IN THE UNITED STATES — 1909 TO 1921—(Concluded)

Preservative	Year	Cubic Feet							
		Cross-Ties	Piles	Poles	Wood Blocks	Cross Arms	Construction Timbers	Miscellaneous Lumber	Total Material Treated
Miscellaneous	1909	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	1910	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	1911	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	1912	2,974,317	14,222	352	305,437	(a)	80,446	28,082	3,402,806
	1913	1,792,287	(a)	84,655	45.185	11,709	(a)	124,367	2,059,008
	1914	7,877 048	257,245	293,896	3,741,864	22,511	(a)	9,367	12,201,922
	1915	19,560	(a)	66,242	1,643,218	3,254	128,377	330	1.855.976
	1916	37,481	56,458	389,081	2,738,731	2,634	166,183	47,416	3,487,884
	1917	680,856	85,204	749,156	4,464,382	16,274	433,896	100,316	6,580,084
	1918	(a)	463,115	62,750	1,881,196	2,541	107,458	60,452	2,077,612
	1919	3,021	(a)	11,775	1,340,850	(a)	114,583	(a)	1,470,229
	1920	35,019	(a)	(a)	(a)	(a)	283,838	(a)	318,857
	1921	29.604	2,040	53,099	(a)	(a)	37,500	19,584	141,827
All Preservatives	1909	62,079,086	4,421,726	659,664	2,994,290	41,764	5,286,120	463,819	75,946,419
	1910	78,467,031	5,257,646	255,507	4,692,458	88,000	8.523,929	2,789,419	100,074,144
	1911	85 182,420	4,937,363	106,218	10,145,724	71,961	8,460,956	2,619,926	111,524,568
	1912	97,183,000	7,737,035	1,188,579	7,397,095	1,643,128	7,793,524	2,988,686	125,931,056
	1913	120,781,248	7,957,922	2,500,420	6 856,298	1,824,719	11,653,628	2,089,658	158,618,838
	1914	131,540,961	8,061,902	1,482,407	6,869,370	417,914	9,847,801	1,362,284	159,582,639
	1915	111,256,755	6,295,284	2,512,780	7,707,971	90,627	11,334,087	1,161,459	140,858,968
	1916	112,408,104	8,582,884	6,747,082	9,944,684	180,844	11,574,101	1,085,333	150,522,982
	1917	100,378,410	8,586,012	6,725,503	9,085,280	256,038	11,495,076	812,817	137,838,586
	1918	91,827,627	8,300,372	4,615,770	6,297,294	428,371	10,215,503	928,863	122,612,890
	1919	112,708,781	9,168,960	6,061,208	4,718,678	75,810	12,061,878	676,136	146,060,994
	1920	134,962,596	8,092,546	10,800,746	6,741,410	318,707	11,645,811	1,238,680	173,800,505
	1921	166,150,545	5,581,999	10,959,256	6,202,904	108,715	11,876,708	758,101	201,648,228

(a) No statistics (b) Fignres if used would reveal identity of reporting firms

Converting Factors
To obtain the number of crossties, divide figures shown by 3
To obtain the number of linear feet of piling, divide the figures shown by .0768
To obtain the number of poles, divide the figures shown by 17.6
To obtain the number of square yards of wood blocks, divide the figures shown by 2.625
To obtain the number of board feet of construction timbers, multiply the figures shown by 12
To obtain the number of crossarms, divide the figures shown by .6198
To obtain the number of board feet of miscellaneous lumber, multiply the figures shown by 12

WOOD-PRESERVING PLANTS IN UNITED STATES, CANADA AND MEXICO

PRESSURE PROCESSES

UNITED STATES

Managing Company	Headquarters	Location of Plant	Year Built	Cylinders		
				No.	Diameter Inches	Length Feet
American Creosoting Co.....	New York, N. Y......	Newark, N. J..............	1906	1 1	78 78	105 165
American Creosoting Co.....	Louisville, Ky.	Indianapolis, Ind.	1913	2	64	134
American Creosoting Co.....	Louisville, Ky.	Marion, Ill.	1907	2	84	134
American Creosoting Co.....	Louisville, Ky.	Springfield, Mo.	1917	2	84	134
American Creosoting Co.....	Louisville, Ky.	Kansas City, Mo...........	1907	2	84	134
American Creosoting Co.....	Louisville, Ky.	Russell, Ky.	1915	1	84	134
American Creosoting Co.....	Louisville, Ky.	Hugo, Okla.	1907	2	84	134
American Creosote Works...	New Orleans, La.....	Southport, nr. New Orleans	1901	1 1	84 108	172 172
American Creosote Works...	New Orleans, La.....	Louisville, Miss.	1912	1	108	172
American Creosote Works...	New Orleans, La.....	Winfield, La.	1908	1 1	72 72	126 80
American Wood Pipe Co...	Tacoma, Wash.	Tacoma, Wash.	1921	1	72	40
Anaconda Copper Min. Co..	Butte, Mont.	Rocker, Mont.	1910	1	72	43
A. T. & S. F. Ry. Co.......	Topeka, Kans.	Albuquerque, N. Mex......	1908	2	74	132
Atlantic Coast Line R.R. Co.	Wilmington, N. C...	Gainesville, Fla.	1912	2	74	138
Atlantic Creo. & W. P. Wks.	Norfolk, Va.	Norfolk, Va.	1901	1 1 1	78 78 78	62 82 126
Ayer & Lord Tie Co........	Chicago, Ill..........	Grenada, Miss.	1904	4	74	128
Ayer & Lord Tie Co........	Chicago, Ill..........	Argenta, Ark.	1907	4	74	132
Ayer & Lord Tie Co........	Chicago, Ill..........	Carbondale, Ill.	1902	4 4	72 74	122 132
Baltimore & Ohio R. R. Co.	Baltimore, Md.......	Spring Green, W. Va......	1912	2	84	132
Boston Elevated Ry. Co....	Boston, Mass........	S. Boston, Mass...........	1916	1	90	51
Buf., Roch. & Pittsb. R. R..	Rochester, N. Y......	Bradford, Pa.	1910	1	75	95
Bunk. H. & Sullivan Mfg.Co.	Kellogg, Idaho	Kellogg, Idaho	1908	1	84	10
Carbolineum Wd. Pres. Co..	Portland, Ore.	Portland, Ore.	1901	1	....	....
Central Creosoting Co......	Chicago, Ill..........	Finney, Ohio	1918	2	72	134
Central of Ga. R. R. Co.....	Macon, Ga.	Macon, Ga.	1912	2	84	116
Central R. R. of New Jersey	Port Reading, N. J..	*Port Reading, N. J........	1912	2	88	140
Charlotte Har. & No. Ry.Co.	Boca Grande, Fla...	Hull, Fla.	1912	1	74	73
C., B. & Q. R. R. Co.......	Chicago, Ill.	Galesburg, Ill.	1907	5	74	132
C., B. & Q. R. R. Co.......	Chicago, Ill.	Sheridan, Wyo.	1899	2	74	132
Chicago & N. W. Ry. Co....	Chicago, Ill.	Escanaba, Mich.	1908	3	72	112
Chicago & N. W. Ry. Co....	Chicago, Ill.	Riverton, Wyo.	1915	1	72	110
Colman Co., J. M..........	Seattle, Wash.	W. Seattle, Wash..........	1884	3	75	120
Colonial Creosoting Co.....	Louisville, Ky.	Bogalusa, La.	1912	2	72	134
Columbia Creosoting Co....	Portland, Ore. ...	Linnton, nr. Portland, Ore.	1912	1 1	72 72	132 65

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* Operated jointly with Philadelphia & Reading R. R. Co.

Pressure Processes—(united states)—Continued

Managing Company	Headquarters	Location of Plant	Year Built	Cylinders		
				No.	Diameter Inches	Length Feet
Compressed Wood Pre. Co.	Cincinnati, O.	Cincinnati, O.	1921	1	72	100
			1909	2	72	76
Continental Tie & Lbr. Co.	Denvel, Colo.	Cimarron, N. M.	1913	1	84	87
El Paso & S. W. R. R. Co.	El Paso, Texas	Alamogordo, N. Mex.	1902	2	72	106
Eppinger & Russell Co.	New York, N. Y.	Long Island City, N. Y.	1878	4	72	100
Eppinger & Russell Co.	New York, N. Y.	Jacksonville, Fla.	1909	3	84	130
Federal Creosoting Co.	Louisville, Ky.	Bound Brook, N. J.	1909	1	84	150
Federal Creosoting Co.	Louisville, Ky.	Toledo, Ohio	1909	3	84	134
Federal Creosoting Co.	Louisville, Ky.	Rome, N. Y.	1910	2	84	150
Federal Creosoting Co.	Louisville, Ky.	Paterson, N. J.	1909	1	84	150
Federal Creosoting Co.	Louisville, Ky.	Livingston Manor, N. Y.	1921	1	84	132
Georgia Creosoting Co.	Louisville, Ky.	Brunswick, Ga.	1915	2	84	121
Georgia Ry. & Power Co.	Atlanta, Ga.	Atlanta, Ga.	......	1	72	50
Gulfport Creosoting Co.	Gulfport, Miss.	Gulfport, Miss.	1906	2	84	120
Hattiesburg Creosoting Co.	Hattiesburg, Miss.	Hattiesburg, Miss.	1920	2	84	150
Indiana Creosoting Co.	Louisville, Ky.	Bloomington, Ind.	1907	1	84	134
Indiana Tie Co.	Evansville, Ind.	Evansville, Ind.	1907	2	72	110
Indiana Tie Co.	Evansville, Ind.	Jappa, Ill.	1900	2	72	110
Indiana Zinc Creosoting Co.	Terre Haute, Ind.	Terre Haute, Ind.	1904	2	72	120
			1912	2	132	20
Interstate Public Service Co	Indianapolis, Ind.	Columbus, Ind.	1909	1	72	45
Int'l Creo. & Con. Co.	Galveston, Tex.	Beaumont, Texas	1892 1897	1	108	140
Int'l Creo. & Con. Co.	Galveston, Tex.	Galveston, Texas	1905	1	72	100
Int'l Creo. & Con. Co.	Galveston, Tex.	Texarkana, Ark.	1902	1	114	165
				1	72	125
Jennison-Wright Co.	Toledo, Ohio	Toledo, Ohio	1910	2	72	130
Kettle River Co.	Madison, Ill.	Madison, Ill.	1909	4	84	135
L. & N. R. R. Co.	Louisville, Ky.	Guthrie, Ky.	1913	2	84	133
				1	72	115
L. & N. R. R. Co.	Louisville, Ky.	Gautier, Miss.	1895	1	72	133
			1916	1	84	133
Los Angeles & S. L. R.R. Co.	Los Angeles, Calif.	Zinc, Calif.	1908	2	72	117
Michigan Wood Pres. Co.	Pittsburgh, Pa.	Reed City, Mich.	1913	1	90	90
Midland Creosoting Co.	Toledo, Ohio	Granite City, Ill.	1917	3	74	140
Mo., Kan. & Tex. Ry. Co.	St. Louis, Mo.	Denison, Texas	1909	4	72	108
Moss Tie Co., T. J.	St Louis, Mo.	Mt. Vernon, Ill.	1899	2	74	132
Moss Tie Co., T. J.	St Louis, Mo.	Granville, Wis.	1921	1	74	118
				1	74	182
Moss Tie Co., T. J.	St. Louis, Mo.	E. St. Louis, Ill.	1921	2	76	150

PRESSURE PROCESSES—(UNITED STATES)—Continued

Managing Company	Headquarters	Location of Plant	Year Built	Cylinders		
				No.	Diameter Inches	Length Feet
Nat'l Lbr. & Creo. Co......	Texarkana, Ark.	Texarkana, Texas	1910	2	84	132
Nat'l Lbr. & Creo. Co......	Texarkana, Ark.	Houston, Texas	1912	4	72	130
Nat'l Lbr. & Creo. Co......	Texarkana, Ark.	Kansas City, Mo..........	1920	2	80	84
Norfolk & Western Ry. Co..	Roanoke, Va.	E. Radford, Va.	1921	2	84	140
Norfolk Creosoting Co......	Norfolk, Va.	Buell (nr. Norfolk), Va..	1896	4	78	100
			1905	1	78	105
				1	84	125
Northern Pacific Co..........	St. Paul, Minn......	Brainerd, Minn.	1907	2	84	134
Northern Pacific Co..........	St. Paul, Minn......	Paradise, Mont.	1907	2	84	133
Ohio Wood Preserving Co...	Pittsburgh, Pa.	Orrville, Ohio	1912	1	84	90
			1921	1	90	90
Ore. Short Line R. R. Co...	Salt Lake City, Utah	Pocatello, Idaho	1921	1	84	132
			1922	1	84	132
Ore.-Wash. R. R. & Nav. Co.	Portland, Ore.	Wyeth, Ore.	1904	4	72	114
Pacific Creosoting Co.......	Seattle, Wash.	Eagle Harbor, Wash......	1906	8	73	125
Pennsylvania System	Philadelphia, Pa. ...	Mt. Union, Pa.............	1909	1	72	132
Pennsylvania System	Philadelphia, Pa. ...	Greenwich, Phila., Pa.....	1910	2	72	132
Phila. & Reading Ry........	Port Reading, N. J..	*Pt. Reading, N. J.........	1912	2	88	140
Pioneer Lbr. & Creo. Co....	Ensley, Ala.	Ensley, Ala.	1911	1	74	76
Pittsburg Wood Preserv. Co	Pittsburgh, Pa.	Connellsville, Pa.	1911	1	84	90
Puget Sound Wood Pres. Co.	Lowell, Wash.	Lowell, Wash.	1895	1	84	117
				1	78	120
				1	74	122
Railway Tie Treating Co....	New York, N. Y.....	Portable, Pa.	1917	3	48	63
Republic Creosoting Co......	Indianapolis, Ind. ..	Mobile, Ala.	1906	2	74	130
Republic Creosoting Co......	Indianapolis, Ind. ..	Indianapolis, Ind.	1908	1	74	130
Republic Creosoting Co......	Indianapolis, Ind. ..	Seattle, Wash.	1916	1	74	130
Republic Creosoting Co......	Indianapolis, Ind. ..	Minneapolis, Minn.	1905	2	74	130
Republic Creosoting Co......	Indianapolis, Ind. ..	Norfolk, Va.	......	.....	....	....
St. Helens Creosoting Co....	Portland. Ore.	St. Helens, Oregon.......	1912	4	84	136
St. Paul & Tacoma Lbr. Co.	Tacoma, Wash.	Tacoma, Wash.	1912	1	84	130
Santa Fe Tie & Lbr. P. Co	Topeka, Kans.	Somerville, Tex.	1906	5	74	132
Savannah Creosoting Co....	New Orleans, La....	Savannah, Ga.	1920	2	96	140
Shreveport Creosoting Co..	Louisville, Ky.	Shreveport, La.	1910	2	84	134
Shreveport Creosoting Co..	Louisville, Ky.	Deridder, La.	......	.....	....	....
Somers Lumber Co..........	Somers, Mont.	Somers, Mont.	1901	4	72	110
Southern Creosoting Co.....	Slidell, La.	Slidell, La.	1902	1	84	150
			1921	2	72	150
Southern Pacific Co.........	San Francisco, Cal..	Latham, Ore.	1898	2	72	117

* Operated jointly with the Central Railroad of New Jersey.

PRESSURE PROCESSES—(UNITED STATES)—Concluded

Managing Company	Headquarters	Location of Plant	Year Built	Cylinders		
				No.	Diameter Inches	Length Feet
Southern Pacific Co	San Francisco, Cal.	W. Oakland, Cal	1887	1 1	72 72	108 138
Southern Pacific Co	San Francisco, Cal.	Los Angeles, Calif.	1907	2	72	112
Southern Pav. & Const. Co.	Chattanooga, Tenn.	Pensacola, Fla.	1912	1	72	90
Southern Wood Pres. Co.	Atlanta, Ga.	Atlanta, Ga.	1908	1	72	100
Tenn. C. I. & R. R. Co.	Birmingham, Ala.	Bessemer, Ala.	1909	1	72	65
Texas & N. O. R. R. Co.	Houston, Texas	Houston, Texas	1890	5	72	112
Union Pacific R. R. Co.	Omaha, Nebra.	Laramie, Wyo.	1909 1921	2 2	73 84	117 132
U. S. Gov't Wood Pre. Plant	New Orleans, La.	New Orleans, La.	1888	1	72	125
Western Wood Pres. Co.	Spokane, Wash.	Yardley, Wash.	1912	1	84	65
Wyckoff Pipe & Creo. Co.	New York, N. Y.	Portsmouth, Va.	1881	4	74	102
Watkins Creosoting Co.	Chicago, Ill.	Metropolis, Ill.	1913 1921	1 1	74 74	142 142
Walsh Tie Co	Minneapolis, Minn.	Minnesota Transfer, St. Paul, Minn.	1921	2	72	123

CANADA

Managing Company	Headquarters	Location of Plant	Year Built	No.	Diameter Inches	Length Feet
Bruce & Co., Alex	Glasgow, Scotland	Fort Francis, Ont.	1912	1	84	76
Canada Creosot. Co., Ltd.	Toronto, Canada	Sydney, N. S.	1911	1	78	85
Canada Creosot. Co., Ltd.	Toronto, Canada	Transcona, Man. (near Winnipeg)	1912	1 3	78 78	94 135
Canada Creosot. Co., Ltd.	Toronto, Canada	Trenton, Ont.	1913	1	84	134
Canada Creosot. Co., Ltd.	Toronto, Canada	Sudbury, Ont.	1920	2	84	150
Dominion Creo. Co., Ltd.	Vancouver, B. C.	Vancouver, B. C.	1910	2	90	100
Dominion Tar & Chem. Co.	Sydney, N. S.	Sydney, N. S.	1911	1	78	85
Dominion Tar & Chem. Co.	Sydney, N. S.	Transcona (nr. Winnipeg, Man.	1912	1 3	78 78	84 135
Vancouver Creo. Co., Ltd.	Vancouver, B. C.	N. Vancouver, B. C.	1916	2	84	135

CENTRAL AMERICA

Managing Company	Headquarters	Location of Plant	Year Built	No.	Diameter Inches	Length Feet
Truxillo, R. R. Co	Boston, Mass.	Puerto Castilla, Rep. of Honduras, C. A.	1920	1	72	65

MEXICO

No data available regarding treating plants in Mexico. The Mexican Central Railroad built a plant at Aguascalientes, Mex., in 1901, to treat railroad ties with zinc chloride. About the year 1907 the Madero Co. built a 2-retort plant at Madera, Chihuahua, Mex., to treat railroad ties with zinc chloride.

NON-PRESSURE PROCESSES

UNITED STATES

Managing Company	Headquarters	Location of Plant	Year Built	Cylinders or Tanks	
				No.	Size—Feet
Allen & Son Co., Otis	Lowell, Mass.	Lowell, Mass.	1848	2	4 x 8 x 50
Allen & Son Co., Otis	Lowell, Mass.	Portsmouth, N. H.	1875	4	4 x 8 x 50
Anaconda Copper Min. Co.	Butte, Mont.	Rocker, Mont.	1909	1	10 x 10 x 10
Baxter & Jordan	Los Angeles, Calif.	Wilmington, Calif.	1911	.....	.....
Bennett Field Tie Co.	Brookport, Ill.	Brookport, Ill.	1920	2	3 x 9 x 24
Brown Company	Portland, Me.	Portland, Me.	1888	1 1	5 x 11 x 35 5 x 11 x 35
Carbolineum Wood Pre. Co.	Portland, Ore.	Portland, Ore.	1910	4	3 x 4 x 60
Carter Bloxonend Floor. Co.	Kansas City, Mo.	Kensett, Ark.	1918	1	4 x 5 x 20
Chapin Co., E. T.	Spokane, Wash.	Bovil, Idaho	1915	2	8 x 12 x 11
Homestake Mining Co.	Lead, S. D.	Lead, S. D.	1908	1	4 dia. x 36
Lindsley Bros. Co.	Spokane, Wash.	Minneapolis, Minn.	1916	2	14 x 18 x 11
Lindsley Bros. Co.	Spokane, Wash.	Priest River, Idaho	1910	2	5 dia. x 11
L. D. McFarland	Sandpoint, Idaho	Sandpoint, Idaho	1919 1919 1921	1 1 1	5 x 5 x 11 9 x 12 x 11 9 x 18 x 10
National Pole Co.	Everett, Wash.	Everett, Wash.	1916	4	30 x 7 x 10
Naugle Pole & Tie Co.	Chicago, Ill.	Chicago, Ill.	1912	2	5 x 5 x 10
Naugle Pole & Tie Co.	Chicago, Ill.	Pinconning, Mich.	1920	.....	.....
Page & Hill Co.	Minneapolis, Minn.	Minneapolis, Minn.	1911	4	6 dia. x 11
P. & R. Coal & Iron Co.	Pottsville, Pa.	New Phialdelphia, Pa.	1908	1	6 dia. x 22
Portland Ry., Lt. & Pr. Co.	Portland, Ore.	Portalnd, Ore.	.....	.....	.....
Public Service Electric Co.	Newark, N. J.	Newark, N. J.	1909	1	10 x 22 x
Puget Snd. Wood Pre. Co.	Lowell, Wash.	Lowell, Mass.	1895	1	3 x 10 x 20
Republic Creosoting Co.	Mobile, Ala.	Mobile, Ala.	1912	1	3 x 9 x 10
San Joaquin L. & P. Co.	Fresno, Calif.	Fresno, Calif.	1910	2	7 x 9 x 9
St. Paul & Tacoma Lbr. Co.	Tacoma, Wash.	Tacoma, Wash.	1915	4	7 x 10 x 20
Southern Calif. Edison Co.	Los Angeles, Calif.	Los Angeles, Calif.	1912	3	10.5 x 8.5 x
Southern Pacific Co.	San Francisco, Cal.	West Oakland, Calif.	1911	1	4 x 6 x 5
United Gas Imp. Co.	Philadelphia, Pa.	Philadelphia, Pa.	.....	.....	.....
U. S. Gov. Wood Pre. Plant	Milan, Ill.	Milan, Ill.	1908	1	4 x 3 x 12

NON-PRESSURE PROCESSES—(UNITED STATES)—Continued

Managing Company	Headquarters	Location of Plant	Year Built	Cylinders or Tanks	
				No.	Size—Feet
Valentine-Clark Co.	Minneapolis, Minn.	Minn. Transfer, St. Paul, Minn.	1908 1908	1 2	12 x 14 x 12 8 dia. x 12
Walsh Tie Co.		Minn. Transfer, St. Paul, Minn.	1921	6	10 x 22 x 11
West. Cedar Pole Pres'vrs.	Spokane, Wash.	Sandpoint, Idaho	1916 1916	2 1	8 x 24 x 11 5 dia. x 11
Western Union Teleg. Co.	New York, N. Y.	Chattanooga, Tenn.	1920	2	7 x 12 x 11

CANADA

Managing Company	Headquarters	Location of Plant	Year Built	No.	Size—Feet
Lindsley Bros.	Spokane, Wash.	Naskup, B. C.	1910	1	6 dia. x 12

AMERICAN WOOD-PRESERVERS' ASSOCIATION

CONSTITUTION

(Amended 1912, 1915, 1916, 1920, 1922)

ARTICLE I

Name and Objects

SECTION 1. The name of this Association shall be AMERICAN WOOD PRESERVERS' ASSOCIATION.

SECTION 2. The objects of the Association shall be the promotion of knowledge of the materials, methods, and principles involved in the economic design, location, construction, maintenance, and operation of wood-preserving works; the standarization of specifications for wood preservatives and for their introduction into the material to be preserved; and the maintenance of high standards of business ethics in the wood-preserving industry.

SECTION 3. The means to be used for these purposes shall be meetings for the presentation and discussion of reports of the experiences and investigations of its members and others, for the interchange of ideas, and for social intercourse; the publication of desirable information; and co-operation with organizations or individuals in work affecting wood-preserving.

ARTICLE II

Membership

SECTION 1. The Association shall consist of Corporate, Associate, Probate, and Honorary Members.

SECTION 2. A Corporate Member shall be an executive, an administrator, or an operative in a wood-preserving organization; an officer of a public-utility corporation using treated wood whose duties cover the purchasing, inspecting, treating, or distribution of such material; a chemist or an engineer in the employ of a city, county, state, nation, or public-utility corporation; a consulting chemical, civil, electrical, forest, or mechanical engineer; or a professor or an instructor in an institution of learning.

SECTION 3. An Associate Member shall be any person interested in wood preservation or in the sale of material or equipment used in the wood-preserving industry.

SECTION 4. A Probate Member shall be an employe of a wood-preserving or inspecting organization who is not eligible for Corporate Membership.

SECTION 5. An Honorary Member shall be a person of acknowledged eminence in the wood-preserving industry or the sciences relating thereto.

SECTION 6. Corporate Members shall have all the rights and privileges of the Association.

SECTION 7. Associate Members shall have all the rights of Corporate Members, except those of voting or holding office.

SECTION 8. Probate Members shall have all the rights of Corporate Members, except those of voting or holding office, for five years from the date of their admission, when their status shall be determined by the Executive Committee.

SECTION 9. Honorary Members shall have all the rights of Corporate Members, except that of holding office, and shall be exempt from the payment of dues.

SECTION 10. A Corporate Member elected after January 1, 1922, who assumes a position not complying with the requirements of Article II, Section 2, shall cease to be classed as a Corporate Member but may retain his membership in the Association as an Associate Member, subject to the provisions of Article II, Section 3.

SECTION 11. An Associate Member who assumes a position qualifying him to be a Corporate Member according to Article II, Section 2, automatically becomes a Corporate Member, subject, however, to Article II, Section 10, if he becomes ineligible to continue as a Corporate Member.

ARTICLE III

Admissions and Expulsions

SECTION 1. Applications for membership and resignations from membership shall be transmitted to the Secretary-Treasurer, the former on a form prescribed by the Executive Committee and endorsed by a Corporate or an Honorary Member. The Secretary-Treasurer shall forward a copy of each application for membership to each member of the Executive Committee, the affirmative votes of a majority of whom shall admit the candidate.

SECTION 2. Proposals for Honorary Membership shall be made by at least ten members, none of whom shall be a member of the Executive Committee. The nominee shall be declared an Honorary Member if he receives the unanimous vote of the Executive Committee or the votes of two-thirds of the Corporate and Honorary members present and voting at an Annual Meeting; provided, however, that there shall be no election to Honorary Membership when such election would make the total number of Honorary Members greater than three per cent of the total number of Corporate Members.

SECTION 3. Any member of the Association who resigns while in good standing may be reinstated without paying a second admission fee, provided his application is approved by two-thirds of the Executive Committee.

SECTION 4. For unbecoming conduct a member may be expelled by the votes of two-thirds of the Corporate and Honorary Members present and voting at an Annual Meeting, after the member has been served with written particulars as to his offense by the Executive Committee, and had an opportunity to be heard by it or by the members at an Annual Meeting.

SECTION 5. The Executive Committee shall accept the resignation, tendered in writing, of any member whose dues are paid.

ARTICLE IV

Dues

SECTION 1. On admission to the Association, members shall pay fees as follows: Corporate Members, $10.00; Associate Members, $15.00; Probate Members, $5.00, which shall include their first dues.

SECTION 2. The annual dues, payable during the first two months of the calendar year, shall be as follows: Corporate Members, $10.00; Associate Members $10.00; Probate Members, $5.00.

SECTION 3. Members admitted after March 31 shall be exempt from the payment of dues until the following January 1, unless they desire to vote or to receive the current publications of the Association, in which case they shall pay one-half of the annual dues.

SECTION 4. Any member whose dues are unpaid on April 1 shall not receive the publications of the Association, and if his dues are not paid by December 31, his membership shall be canceled, except as provided for in Section 5 of this Article.

SECTION 5. The Executive Committee may extend the time for paying or remit the dues of any Corporate or Probate members who are unable to pay them.

ARTICLE V

Officers

SECTION 1. The officers of the Association shall be Corporate Members and shall consist of a President, a First Vice-President, a Second Vice-President, a Secretary-Treasurer, and six Members of Executive Committee, who together with the last Past-President who is a Corporate Member, shall constitute the Executive Committee in which responsibility for the government of the Association shall be vested. The President shall be chosen from the nine eligible members of the Executive Committee.

SECTION 2. No two or more officers in any year shall be members of the same business organization.

SECTION 3. The President, the First Vice-President, the Second Vice-President, the Secretary-Treasurer, and two Members of Executive Committee shall be elected at each Annual Meeting.

SECTION 4. The terms of the President, Vice-Presidents, and Secretary-Treasurer shall begin at the close of the Annual Meeting at which they are elected and continue until their successors are elected and have qualified. The six Members of Executive Committee shall serve three years, two being elected each year.

SECTION 5. A vacancy in the office of President shall be filled by the Vice-Presidents in order.

SECTION 6. A vacancy in any office other than that of President shall be filled by an appointee of the Executive Committee.

SECTION 7. The President shall not be eligible for re-election to that office until three others have filled it. A Vice-President shall not be eligible for re-election to the same office until one other has filled it.

ARTICLE VI

Nomination and Election of Officers

SECTION 1. At each Annual Meeting six Corporate Members who are not officers shall be elected, together with the three last Past-Presidents who are Corporate Members, to serve one year as a Nominating Committee, of which the senior Past-President shall be chairman.

SECTION 2. The Nominating Committee shall nominate one eligible member for each office and for each membership in the Nominating Committee and shall send its list of nominees to the Secretary-Treasurer before October 15. Any vacancies that may occur in the list of nominees before it is sent to the members shall be filled by the Executive Committee.

SECTION 3. The voting shall not be restricted to the names presented by the Nominating Committee. Any member may file with the Secretary-Treasurer before November 1 the name of a candidate for any office.

SECTION 4. The ballot, with envelopes for secret voting, shall be sent to each member before December 1. It must contain the names of all nominees for each office, arranged alphabetically where there is more than one name for any office, with the nominees of the Nominating Committee plainly indicated.

SECTION 5. Members may scratch or substitute the name of any nomineee for any office.

SECTION 6. Ballots shall be sealed and sent or delivered to the Secretary-Treasurer before the polls close, prior to which time a voter may withdraw or replace his ballot.

SECTION 7. The polls shall be closed at noon on the first day of the Annual Meeting, and the ballots shall be counted by one Corporate and four Associate or Probate Members, appointed tellers by the presiding officer at the Annual Meeting.

SECTION 8. The persons who receive the highest number of votes for the offices for which they are candidates shall be declared elected. In case of a tie between candidates for the same office, the members present at the Annual Meeting shall elect the officer from the candidates so tied. The presiding officer shall announce to the meeting the names of the officers elected.

ARTICLE VII

Management

SECTION 1. The President shall have general supervision of the affairs of the Association, shall preside at its meetings and those of the Executive Committee, and shall be a member *ex-officio* of every committee except the Nominating Committee.

SECTION 2. The Vice-Presidents, in order of seniority, shall preside at meeting in the absence of the President and discharge his duties in case of a vacancy in the office.

SECTION 3. The Secretary-Treasurer, under the direction of the President and the Executive Committee, shall be the executive officer of the Association. He shall conduct the correspondence of the Association; record the proceedings of all meetings; collect and deposit all moneys due the Association; verify all bills and pay them when approved by the President or Executive Committee; make at each Annual Meeting a report of the accounts and membership of the Association; and perform such other duties as may be assigned to him by the Executive Committee.

SECTION 4. The Executive Committee shall manage the affairs of the Association, and shall have full power to control and regulate all matters not provided for in the Constitution. It shall act on applications for memberships; make appropriations for specific purposes; direct the care of the surplus funds of the Association; and audit the accounts of the Secretary-Treasurer.

SECTION 5. The Executive Committee shall publish the activities of the Association in a book to be known as the Annual Proceedings; but, subject to the action of the Association, it may withhold, in whole or in part, discussions, papers, or reports, the propriety or soundness of which is considered questionable.

SECTION 6. The Executive Committee shall have printed a Manual of Recommended Practice, in which shall be published the specifications and standards approved by the Association in accordance with Article X.

SECTION 7. The Executive Committee shall meet at such times and places as the President may direct, or five members may request in writing. Six members shall constitute a quorum.

ARTICLE VIII

Meetings

SECTION 1. An Annual Meeting, at which the officers shall be elected and all annual reports read, shall be held on the fourth Tuesday in January of each year, at ten o'clock A. M. at such place as the Association at the previous meeting may designate, provided, however, that if conditions arise which make it seem to the Executive Committee inadvisable to hold an Annual Meeting at the time or place designated, the Executive Committee shall have authority to designate another time or place for the meeting.

SECTION 2. Whenever the President may deem it necessary, or upon the written application of fifteen Corporate Members, he shall direct the Secretary-Treasurer to call a special meeting. The call for such a meeting shall state the time, place, and purpose of the meeting, and shall be mailed not less than thirty days prior to the date of the proposed meeting.

SECTION 3. Twenty Corporate Members shall constitute a quorum at any meeting of the Association.

SECTION 4. The order of business at the meetings of the Association shall be arranged by the Executive Committee, subject to addition or change by the votes of the majority of the members present.

ARTICLE IX

Amendments

SECTION 1. Proposed amendments to this Constitution must be offered in writing, signed by at least five Corporate Members, and forwarded to the Secretary-Treasurer not less than thirty days prior to the Annual Meeting. They shall be published with the notices for the meeting.

SECTION 2. Proposed amendments shall be in order for discussion at the Annual Meeting, and may be amended and adopted if two-thirds of the votes of the Corporate and Honorary Members present and voting are affirmative.

ARTICLE X

Adoption of Standards

SECTION 1. Any proposal for the approval of the Association of definitions, methods, nomenclature, specifications, standard construction or standard practice, or aimed at defining formally the position of the Association, shall have been made the subject of a study by a standing or special committee and embodied in a committee report published and distributed to the members of the Association not less than fifteen days prior to an Annual Meeting.

SECTION 2. The reports of committees embodying such proposals shall be in order for discussion at an Annual Meeting and shall be referred to letter ballot of the Association if a majority of the votes of the Corporate and Honorary Members present and voting is affirmative. Any proposal so submitted shall have the approval of the Association if a majority of the votes cast upon it by letter ballot is affirmative.

SECTION 3. The reports of committees embodying such proposals may be amended before submission to letter ballot if the votes of two-thirds of the Corporate and Honorary Members present and voting are affirmative; provided, however, that if, in the judgment of the committee submitting the report, any amendment so adopted affects underlying principles, that part of the report so affected shall be referred back to the committee for further consideration.

Past and Present Officers of the American Wood-Preservers' Association

Number	Year Elected	President	First Vice-President	Second Vice-President	Third Vice-President	Secretary-Treasurer
1st------	1905	J. S. Baker	C. B. Lowry †	H. J. Whitmore †	F. A. Kummer *	C. W. Berry
2nd -----	1906	C, B. Lowry †	E. O. Faulkner	Edmund Christian*	David Allerton	C. W. Berry
3rd------	1907	C. B. Lowry †	David Allerton	Walter Buehler	H. S. Valentine	C. W. Berry
4th------	1908	Walter Buehler	C. B. Lowry †	David Allerton	H. S. Valentine	C. W. Berry
5th------	1909	Walter Buehler	David Allerton	H. S. Valentine	H. M. Rollins	C. W. Berry
6th------	1910	Walter Buehler	C. W. Berry	David Allerton	C. D. Chanute †	F. J. Angier
7th------	1911	John T. Logan	Andrew Gibson	R. J. Calder	D. Burkhalter	F. J. Angier
8th------	1912	E. A. Sterling	A. M. Smith	H. M. Rollins	G. B. Shipley	F. J. Angier
9th------	1913	A. E. Larkin	J. H. Waterman	E. B. Fulks	Geo. E. Rex	F. J. Angier
10th------	1914	Geo. E. Rex	Carl G. Crawford	R. S. Manley	F. B. Ridgeway *	F. J. Angier
11th------	1915	J. H. Waterman	H. S. Loud	Lowry Smith	F. D. Beal *	F. J. Angier
12th------	1916	Carl G. Crawford	John Foley	M. K. Trumbull	----	F. J. Angier
13th------	1917	John Foley	M. K. Trumbull	J. B. Card	----	F. J. Angier
14th------	1918	M. K. Trumbull	J. B. Card	A. R. Joyce	----	F. J. Angier
15th------	1919	J. B. Card	A. R. Joyce	C. M. Taylor	----	F. J. Angier
16th------	1920	A. R. Joyce	C. M. Taylor	E. B. Fulks	----	F. J. Angier
17th------	1921	C. M. Taylor	F. J. Angier	H. S. Valentine	----	Geo. M. Hunt
18th------	1922	F. J. Angier †	W. H. Grady	H. S. Sackett	----	S. D. Cooper

In 1915 the Executive Committee was increased to 11 members, the 6 additional members to serve from 1 to 3 years.
In 1916 the office of Third Vice-President was abolished.

* Resigned
† Deceased

Meetings

Year	City	Hotel	Members Present	Visitors Present	Number of Pages in Proceedings	Number of Papers and Reports Presented
1905	New Orleans	St. Charles	15	No record	37	7
1906	Chicago	Palmer	16	No record	56	9
1907	Memphis	Baltimore	16	No record	64	10
1908	Kansas City	Gayoso	No record	No record	Not issued	--
1909	Chicago	Auditorium	---	100	141	12
1910	Chicago	Auditorium	24	74	190	14
1911	Chicago	Auditorium	50	70	302	20
1912	Chicago	Sherman	67	--	348	17
1913	Chicago	Sherman	83	36	525	22
1914	New Orleans	St. Charles	65	48	544	25
1915	Chicago	Congress	122	105	527	23
1916	Chicago	Sherman	115	89	432	31
1917	New York	Astor	100	133	538	26
1918	Chicago	Sherman	88	51	262	22
1919	St. Louis	Statler	104	141	309	30
1920	Chicago	Sherman	119	110	369	24
1021	San Francisco	St. Francis	74	58	590	34
1922	Chicago	Sherman	162	90	531	33

AMERICAN WOOD-PRESERVERS' ASSOCIATION

LIST OF MEMBERS

(Complete to March 31, 1922)

Figures indicate serial number of Membership Certificate

c-Corporate. a-Associate. p-Probate. h-Honorary.

384 c ADAMS, CHARLES ....Supt., Wood Preserving Works, Southern Pacific Railroad, Cottage Grove, Oregon.
183 c ALEXANDER, E. E.....Supervisor of Plants, Baltimore and Ohio Railroad, Green Spring, W. Va.
29 c ALLARDYCE, R. L.....Gen. Supt., International Creosoting and Construction Co., Texarkana, Texas.
360 a ALLEN, E. J...........Ties and Lumber, 32 Broadway, New York City.
21 h ALLERTON, DAVID ... Winters, Cal.
443 c ALMON, W. D..........
569 c AMADON, H. H........In Charge Inspection, Western Electric Co., 463 West St., New York City.
554 c AMIS, J. C.............Chief Engr., Detroit and Mackinac Railway, East Tawas, Mich.
531 c ANDERSON, H. A...... Engineer, Physical Laboratory, Western Electric Co., 463 West St., New York City.
405 c ANDREWS, HOWARD . Pres., Nashville Tie Co., Nashville, Tenn.
632 c ANGIER, R. N.......... Chemical Engineer, Timber Treating Plant, B. & O. Ry. Co., Green Spring, W. Va. (1922).
407 c ARMSTRONG, A. W....Sec'y–Treas., Ayer and Lord Tie Co., Chicago, Ill.
494 c ARMSTRONG, W........Sales Mgr., Creosoted Block Paving Co., Ltd., Toronto, Canada.
475 c ASHBY, H. N..........Mfg. Dept., Long–Bell Lumber Co., Kansas City, Mo.
550 c AUSTIN, H. E..........Chief Engr., American Creosoting Co., Louisville, Ky.

547 c BABCOCK, E. B........Chief Inspector Pacific Northwest, R. W. Hunt and Co., 410 Lyon Bldg., Seattle Wash.
105 c BACON, W. L..........Supt., Tie Treating Plant, Chicago and Northwestern Railway, Escanaba, Mich.
411 c BADE, J. H............Ass't Supt., Central Creosoting Co., North Bend, Ohio.
3 h BAKER, J. S............Oaklawn Sugar Co., Ltd., Franklin, La.
(Charter)
571 c BALL, W. C............Sales Mgr., Chas. R. McCormick Co., 900 Fife Bldg., San Francisco, Cal.
410 c BARBER, F. A.........Indiana Zinc Creosoting Co., Terre Haute, Ind.
379 a BARTH, KURT C......Technical Representative, The Barrett Co., 821 Market St., San Francisco, Cal.
635 c BARTELLS, E. J.......Construction Engineer, 523 White Bldg., Seattle, Wash. (1922).
167 c BATEMAN, ERNEST ..Chemist in Forest Products, Forest Products Laboratory, Madison, Wis.
88 c BATSON, C. D.........Mgr., Republic Creosoting Co., Mobile, Ala.
604 c BATSON, ROBERT P...Sec'y and Treasurer, Creosote Supply Co., 904 Hibernia Bldg., New Orleans, La. (1922).
460 c BAXTER, ALFRED M..Care J. H. Baxter & Co., 702 National Bank Bldg., San Francisco, Cal.
198 c BECKER, A. C.........9 Monument Avenue, Dayton, Ohio.
145 c BELCHER, R. S........Mgr., Treating Plants, Atchison, Topeka and Santa Fe Railway, Topeka, Kans.
479 c BELL, H. C............Supt., Tie Treating Plant, Norfolk & Western Ry. Co., Roanoke, Va.
593 c BEMIS, GEO. M........Supt., Wood Preserving Plant, C. & N. W. Ry. Plant, Riverton, Wyo.
622 a BENNETT, ALFRED .. President, Bennett, Field & Co., 1406 Fisher Bldg., Chicago, Ill. (1922).
639 c BERNHARDT, J. E....Bridge Engineer, Chicago & Eastern Illinois Ry. Co., 6600 South Union Ave., Chicago, Ill. (1922).
144 c BERK, P. F............Chemical Mfr., F. W. Berk & Co., Ltd., 1 Fenchurch Ave., London, England.

444	a	BERMINGHAM, EDW.	Sales Dept., International Coal Products Corporation, 24 Broad St., New York City.
207	a	BERNUTH, OSCAR	Pres., Bernuth, Lembcke Co., Inc., 171 Madison Avenue, New York City.
5	h	BERRY, C. W. (Charter)	Care Geo. E. Littlefield, Cliff Drive, Santa Barbara, Cal.
300	c	BLACK, JAMES M.	Care J. B. Showalter, 510 East Clifton Terrace, Washington, D. C.
561	a	BLACKALL, ROB'T H.	Mfr. of Railway Supplies, 1305 Farmers' Bank Bldg., Pittsburgh, Pa.
598	a	BLAGDEN, VICTOR	Victor Blagden Co., 4 Lloyds Ave., London, E. C. 3 England.
537	a	BLASSINGHAM, M. T.	Pres. and Treas., M. T. Blassingham & Co., Inc., Norfolk, Va.
22	c	BOEHNE, E. E.	Mgr. Sales Dept., International Creosoting & Construction Co., Galveston, Texas.
477	c	BOOK, J. E.	Supt., Pacific Creosoting Co., Creosote, Kitsap County, Wash.
642	c	BOWDEN, I. V.	Tie and Timber Agent, Kansas City Southern Ry., Kansas City, Mo. (1922).
244	c	BOWSER, E. H.	Supt. Timber Dept., Illinois Central Railroad, Memphis, Tenn.
447	c	BOYER, LOUIS	Electrical Eng., Establissements Gaillard, 7 F, Rue Sebastapol, Beziers, France.
563	a	BRADLEY, MARK	Sales Mgr., Monsanto Chemical Works, St. Louis, Mo.
628	a	BRANDE, E. B.	President, B. H. Carney & Co., Grinnell, Iowa (1922).
280	p	BRENNAN, T. S.	Lumber Inspr., Atchison, Topeka and Santa Fe Railway, P. O. Box 162, Seattle, Wash.
368	a	BREYER, FRANK G.	Chief of Research Dept., New Jersey Zinc Co., Palmerton, Pa.
406	c	BRIGGS, Z. M.	Ass't Eng. Maintenance, Pennsylvania System, Pittsburgh, Pa.
301	c	BRIGHT, EDGAR W.	Pres., Mass. Lumber and Creosoting Co., 104 Milk St., Boston, Mass.
507	c	BROWN, A. A.	Construction Eng., California and Hawaiian Sugar Refining Co., Crockett, Cal.
230	c	BROWN, NELSON C.	New York State College of Forestry, Syracuse, N. Y.
377	a	BROWN, S. K.	Vice. Pres. and Gen. Mgr., American Tie and Timber Co., 11 Broadway, New York City.
499	c	BRUNNIER, H. J.	Designing and Consulting Structural Engr., 312 Sharon Bldg., San Francisco, Cal.
408	c	BRYAN, GORDON	Florida Lumber and Crate Co., Kissimee, Fla.
23	c	BUEHLER, WALTER	Engr. of Wood Preservation, The Barrett Co., 40 Rector St., New York City.
24	c	BURKHALTER, D.	Supt., Indiana Creosoting Co., Bloomington, Ind.
338	c	BURY, RICHARD A.	Asst. General Tie Agent, New York Central Lines, Michigan Central Passenger Terminals, Detroit, Mich. (1922)
472	c	BURNES, JOHN D.	Care Page & Hill Co., 814 Plymouth Bldg., Minneapolis, Minn.
546	c	BUSH, H. O.	Lumber and Tie Inspector, Erie Railroad, 50 Church St., New York City.
83	a	CABOT, SAMUEL	Manufacturing Chemist, 141 Milk St., Boston, Mass.
590	c	CAESAR, GEO. V.	Supt. Creosoting Dept., American Wood Pipe Co., Tacoma, Wash.
30	c	CALDER, R. J.	Vice Pres., International Creosoting & Construction Co., Galveston, Texas.
388	c	CALVIN, R. A.	Sales Mgr., The Kettle River Co., Madison, Ill.
190	c	CAMPBELL, J. H.	Chemical Engr., R. W. Hunt & Co., 2200 Insurance Exchange, Chicago, Ill.
43	c	CARD, J. B.	Pres., Central Creosoting Co., 111 W. Washington St., Chicago, Ill.
352	c	CARPENTER, W. M.	Vice Pres., American Line Materials Co., McCormick Bldg., Chicago, Ill.
609	c	CATE, THOMAS A.	Supt., Ohio Wood Preserving Co., Orville, Ohio (1922).
276	c	CECIL, WM. A.	Wood Preserving Engr., Indiana Tie Company, Evansville, Ind.
476	c	CHADBOURNE, B.	Office Mgr., Pacific Creosoting Co., 204 Northern Life Bldg., Seattle, Wash.
392	c	CHADWICK, CHAS. S.	Gen. Mgr., Eppinger and Russell Co., 165 Broadway, New York City.
302	c	CHAPIN, E. T.	Pres., E. T. Chapin Co., Columbia Bldg., Spokane, Wash.
69	c	CHERRINGTON, F. W.	Dir. Engr. Sales, The Jennison-Wright Co., Toledo, O.

372 c CHILCOAT, G. W. .....Foreman, Mt. Union Wood Preserving Plant, Pennsylvania System, Mt. Union, Pa.
57 a CHURCH, SUMNER R..Mgr. Oil and Tar Dept., The Barrett Co., 40 Rector St., New York City.
560 c CLARK, E. L. ....Pres., Valentine-Clark Co., 510 Peyton Bldg., Spokane, Wash.
629 c CLARK, W. A..........Chief Engr., Duluth & Iron Range R. R., Duluth, Minn. (1922)
386 c CLARKE, ROY C......Treating Inspr., Pittsburgh and Lake Erie Railroad, P. & L. E. Terminal Bldg., Pittsburgh, Pa.
165 c CLARKE, G. S.........U. S. Army.
319 p CLEMENTS, C. M. .....Supt. Plant, Railway Tie Treating Co., Inc., Box 198, Lancaster, Pa.
385 a CLIFFORD, W. E......Chemical Engr., Care Mysore Distillation & Iron Works, Bhadravate M. & S. M. Ry., Mysore, India.
174 a CLIFTON, W. H. ......Vice Pres., Anguera Lumber and Tie Co., 1101 Conway Bldg., Chicago, Ill.
594 a COALE, H. D. ....Chief Engr., Continental Pipe Mfg. Co., Box 1902, Seattle, Wash.
365 c COLLINS, E. S.........347 Pittock Block, Portland, Oregon.
397 c COLLSTROP, A. ....Chairman, R. Collstrop, Ltd., Copenhagen, Denmark.
67 c COLMAN, GEO. A......Colman Creosoting Works, Colman Bldg., Seattle, Wash.
553 c COLMAN, L. J. ....Pres., Colman Creosoting Works, Seattle, Wash.
493 c CONDON, H. R. ....Ass't Forester, Pennsylvania System, Broad St. Station, Philadelphia, Pa.
536 a COOK, WM. P. ....Wm. P. Cook & Co., 79-85 Wall St., New York City.
535 a COONEY, C. T..........Sec'y-Treas., Cooney, Eckstein & Co., 302 Broadway, New York City.
221 c COOPER, S. D. ....Ass't Mgr. Treating Plants, Atchison, Topeka and Santa Fe Railway, Topeka, Kans.
508 c CORTES, CARLOS E...Construction Engr., Shell Company, Martinez, Cal.
31 c CRAWFORD, C. G......Vice Pres., American Creosoting Co., Louisville, Ky.
641 c CROOK, FRANK D.....Engineer of Tests, City Engineer's Office, Seattle, Wash. (1922).
452 c CURRY, J. H. ....Boring Machine Foreman, Atchison, Topeka and Santa Fe Railway, National City, Cal.
515 c CURTIN, M. J..........Tie and Timber Agent, Boston Elevated Ry. Co., Boston, Mass.

25 c DAVIDSON, G. M. .....Industrial Engr., Chicago and Northwestern Railroad, Chicago, Ill.
143 c DAVIES, E. T. ....Inspector, City Engineer's Office, 125 Bryant Ave. N., Minneapolis, Minn.
510 a DAVIS, H. E. ....Sales Div'n Mgr., The Grasselli Chemical Co., Cleveland, Ohio.
524 a DAVIS, JOHN W.......Gen. Supt., American Tar Products Co., 208 South La Salle, St., Chicago, Ill.
601 c DAVIS, CHAS. T. ......Supt., T. & N. O. Ry. Co., Broadway Blvd., Park Place, Houston, Tex.
557 c DAWSON, THOS. W....Chief Engr., H. C. Frick Coke Co., Scottdale, Pa.
84 c DeCEW, J. A...........Chem. Engr., 501 Fifth Ave., New York City.
530 c DEUTSCH, MARG. F...Statistician, Forest Products Laboratory, Madison, Wis.
223 c DIXON, G. C. ....Tie Treating Inspr., C. C. C. & St. L. Railway, Indianapolis, Ind.
64 c DIXON, J. H. ....Burd Ring Sales Co. of Canada, 322 McIntyre Block, Winnipeg, Man., Canada.
424 c DOAN, WM. E..........Vice Pres., Canada Creosoting Co., Toronto, Canada.
121 c DRAPER, E. G.........Pres., American Creosoting Co. of New Jersey, 17 Battery Place, New York City.
166 a DREFAHL, L. C........Operating Dept., Grasselli Chemical Company, Cleveland, Ohio.
383 c DRESSER, GEO. L.....Sales Engr., The Jennison-Wright Co., Albany, N. Y.
178 c DUNSTAN, J. H........Supt., Southern Creosoting Co., Slidell, La.
211 c DURHAM, J. H.........Vice Pres., American Creosoting Co., Louisville, Ky.
322 c DUTTON, ELLIS R.....Ass't City Engr., Minneapolis, Minn.
582 a DWYER, M. B.........Mfgs. Agent, Penna. Salt Mfg. Co., 2012 Railway Exchange Bldg., St. Louis, Mo.

202 a EASTWICK, C. H.......Pres., Northeastern Co., 80 Beverley St., Boston, Mass.
418 a EDWARDS, D. W......Representative, Greenlee Bros. & Co., Takoma Park, Washington, D. C.
606 c EDDINS, WM. E.......Vice Pres., Hattiesburg Creosoting Co., Hattiesburg, Miss. (1922).

481	c	EGGLESTON, R. C.	Forester, American Telephone & Telegraph Co., Care H. M. Fales, District Plant Supt., Minneapolis, Minn.
393	c	ELAM, WM.	Store Dept., Missouri, Kansas and Texas Ry., Parsons, Kans.
612	c	ELDER, SAMUEL M.	Lumber Agent, B. & O. Ry., 703 Baltimore & Ohio Bldg., Baltimore, Md. (1922).
275	c	EMERSON, H.	Pres., The Emerson Co., 30 Church St., New York City.
577	c	ENRIGHT, F. M.	Pres., Creo-Fir Wood Block Paving Co., 138 No. LaSalle St., Chicago, Ill.
578	c	ENTRICAN, ALEX. R.	Engineer in Forest Products, State Forest Service, Wellington, New Zealand.
163	c	ERICSON, L. T.	Chief Engr., The Jennison-Wright Co., Toledo, Ohio.

341	c	FAIRLEY, ROBT. H.	Plant Supt., St. Helens Creosoting Co., St. Helens, Ore.
451	c	FALCONER, R. C.	Chief Engr., The Erie Railroad, 50 Church St., New York City.
158	c	FANT, A. E.	Pres., Gulfport Creosoting Co., Gulfport, Miss.
9	h	FAULKNER, E. O. (Charter)	Mgr., Tie and Timber Dept., Atchison, Topeka and Santa Fe Railway, Los Angeles, Cal.
544	c	FAYLOR, C. E.	Union Cedar Co., 1501-5 2nd National Bank Bldg., Toledo, Ohio.
239	c	FERGUSSON, H.	Gen. Mgr., Burt, Boulton & Haywood, Ltd., Prince Regent's Wharf, Silverton, Victoria Docks, London, England.
237	c	FINKE, W. F. H.	Tie and Timber Agent, Southern Railroad, Washington, D. C.
62	c	FISHER, WM. A.	Bernuth Lembcke Co., Inc., 171 Madison Ave., New York City.
308	a	FOERSTERLING, H.	The Arbor Farm, Jamesburg, N. J.
77	c	FOLEY, JOHN	Forester, Pennsylvania System, Broad Street Station, Philadelphia, Pa.
106	c	FORD, C. F.	Supt. Tie and Timber Department, Chicago, Rock Island and Pacific Ry., Chicago, Ill.
611	c	FOSTER, HARRY W.	Supt., Kettle River Co., Madison, Ill. (1922).
313	c	FOWLER, J. W.	Sales Rep., Hoggson Brothers, 485 Fifth Avenue, New York City.
568	a	FOX, M. J.	Sec'y-Treas., Von-Platen-Fox Co., Iron Mountain, Mich.
491	c	FRANCE, R. L.	Lumber and Fuel Agent, Southern Pacific Co., San Francisco, Cal.
640	c	FRANDSEN, F. K. O.	Chemist, A. T. & S. F. Ry. Co. Tie Treating Plant, Albuquerque, N. M. (1922).
624	c	FRENCH, A. C.	Supt. Wood Preserving Plant, Oregon Short Line, Box 945, Pocatello, Idaho (1922).
117	c	FREY, GEO. W.	Gen. Mgr., Compressed Wood Preserving Co., 4665 Spring Grove Ave., Cincinnati, Ohio.
333	c	FRISTOE, J. W.	Pres., T. J. Moss Tie Co., St. Louis, Mo.
347	c	FRITZ, C. C.	Treating Engr., Long-Bell Lumber Co., Kansas City, Mo.
454	c	FRYE, RALPH K.	Mgr., Post, Pole and Paving Block Sales, Long-Bell Lumber Co., Kansas City, Mo.
38	c	FULKS, E. B.	Pres., Arkansas Preservative Co., St. Louis, Mo.
160	a	FULWEILER, W. H.	Chemist, United Gas Improvement Co., Philadelphia, Pa.
306	a	FURLONG, L. A.	Vice Pres., Walsh Tie Co., 910-914 Security Bldg., Minneapolis, Minn.

456	c	GARLAND, FRANK J.	Selling Agent, St. Helens Creosoting Co., San Diego, Cal.
44	a	GERHARD, H. H.	Pres., C. A. Wood Preserver Co., St. Louis, Mo.
482	c	GIBBONEY, J. H.	Chief Chemist, Norfolk and Western Ry., Roanoke, Va.
39	c	GIBSON, ANDREW	Supt. Timber Preservation, Northern Pacific Railroad, Brainerd, Minn.
180	a	GIBSON, W. C.	Branch Mgr., Milwaukee Tank Works, 903 Fisher Bldg., Chicago, Ill.
512	a	GOLDEN, W. J.	Gen. Mgr., By-Products Steel Corporation, Weirton, W. Va.
56	c	GOLTRA, W. F.	Pres., W. F. Goltra Tie Co., Cleveland, Ohio.
288	c	GOSLINE, C. E.	Roadmaster, Delaware, Lackawanna and Western Railroad, Hoboken, N. J.
277	c	GOSS, O. P. M.	Consulting Timber Engr., Goss & Rawson, 504 White Bldg., Seattle, Wash.
630	c	GOWING, E. P.	Salesman, American Creosoting Co., 401 W. Main St., Louisville, Ky. (1922).

595	c	GOODWIN, W. R	Engr. Wood Preservation, M., St. P. & S. S. M. Ry. Co., R. R. No. 2, Hopkins, Minn.
243	c	GRADY, W. H	Gen. Supt., American Creosoting Co., 401 West Main St., Louisville, Ky.
100	c	GRAHAM, FLOYD N.	Chief Timber Inspr., Chicago Great Western, Chicago, Ill.
445	c	GRAHAM, R. A.	Supervisor of Treatment, Missouri Pacific, 551 Veronica Ave., E. St. Louis, Ill.
522	a	GRAMM, CHAS. WM.	Salesman, Ernst Zobel Co., 2nd Ave. and 10th St., Brooklyn, N. Y.
486	c	GREENE, C. W	Timber Treatment Engr., New York Central Railroad, 581 Durango Drive, Toledo, Ohio.
548	a	GREENEBAUM, M	Vice Pres., Kern Commercial Co., 114 Liberty St., New York City.
559	a	GREIG, WM. R	Salesman, Paraffine Companies, 34 First St., San Francisco, Cal.
334	c	GRIGGS, E. G	Pres., St. Paul and Tacoma Lumber Co., Tacoma, Wash.
72	a	GROW, J. H	Engr. Wood Preservation, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
635	p	GROSS, H. W	Yard Foreman, Baltimore & Ohio Ry., Green Spring, W. Va. (1922).
534	a	GUTSCHOW, PAUL	Mgr., Bardewyck, 150 Nassau St., New York City.
231	c	HAGGANDER, G. A.	Ass't Bridge Engr., Chicago, Burlington and Quincy Railroad, Chicago, Ill.
442	a	HAMILTON, C. L.	Sec'y, Weyerhaeuser Forest Products, St. Paul, Minn.
195	c	HAMILTON, F. P	Creosoted Materials Co., Inc., New Orleans, La.
562	c	HAMILTON, R. M	Gen. Foreman, Central Creosoting Co., 7223 Lower River road, Fern Bank, Cincinnati, Ohio.
473	c	HARPER, LEWIS H.	Supt. Creosote Plant, Central of Georgia Railway, Crump's Park, Ga.
425	c	HARRELL, E. H	E. H. Harrell Co., Houston, Texas.
529	c	HARRIS, GEO. H	Gen. Supt., San Francisco-Oakland Terminal Railways, Oakland, Cal.
187	c	HARRIS, PAGE	Vice Pres., National Lumber & Creosoting Co., Houston, Texas.
82	c	HARTMAN, E. F	Pres., Protexol Corporation, 34 Barclay St., New York City.
53	a	HAWKES, A. W	Vice Pres., General Chemical Co., 25 Broad St., New York City.
527	c	HEIM, A. L.	Engr. in Forest Products, Forest Products Laboratory, Madison, Wis.
588	a	HEINEMAN, E. E	Tie Manufacturer, Merrill, Wis.
236	c	HELSON, J. R	Supt. Watkins Creosoting Co., Metropolis, Ill.
521	a	HENDERSON, C. T.	Sales Mgr., Great Western Electro Chemical Co., San Francisco, Cal.
103	c	HENDRICKS, V. K	131 North 8th St., Terre Haute, Ind.
422	a	HENDRICKS, W. H.	Gen. Sales Mgr., New Jersey Zinc Co., 160 Front St., New York City.
335	c	HERMANN, GEO. E.	Mgr., Vaucouver Creosoting Co., Ltd., North Vancouver, B. C.
75	c	HESS, LAWRENCE E.	Ass't Supt., Republic Creosoting Co., Indianapolis, Ind.
370	c	HICKS, P. R	Secretary-Manager, Service Bureau, A. W. P. A., 1146 Otis Bldg., Chicago, Ill.
409	a	HICKS, S. D	931 Indiana Ave., Monaca, Pa.
518	c	HILL, C. L	U. S. Forest Service, Ferry Bldg., San Francisco, Cal.
320	c	HILL, L. L	Sec'y, Page & Hill Co., Minneapolis, Minn.
552	a	HINCKLEY, G. W	Pres., Geo. W. Hinckley & Co., 63 Wall St., New York City.
449	c	HOGUE, CHESTER J.	Engr. in Forest Products, West Coast Lumbermen's Ass'n, 3734 Grand Central Terminal, New York City.
618	c	HOLBROOK, R. C	Supt., Truxillo R. R. Co., Rep. of Honduras, Central America (1922).
616	a	HOLTMAN, D. F	Construction Engr., National Lbr. and Mfgs. Assn. of Chicago, Southern Bldg., Washington, D. C. (1922).
364	c	HOPKINS, H. W	Lumber Inspr., Pennsylvania System, Jacksonville, Fla.
179	c	HORROCKS, H. E.	Mgr., Pacific Creosoting Co., Seattle, Wash.
359	c	HOSFORD, R. F	Telephone Engr., American Telephone and Telegraph Co., 195 Broadway, New York City.
625	c	HOSKINS, J. W	Supt., T. J. Moss Tie Co., Mount Vernon, Ill. (1922).
573	c	HOWE, PAUL J	Construction Engr., Western Union Telegraph Co., 195 Broadway, New York City.
193	c	HOWSON, E. T	Editor, "Railway Maintenance Engineer," Transportation Bldg., Chicago, Ill.

350 c HOXIE, F. J...........Insurance Engineer, Associated Factory Mutual Fire Insurance Companies, 31 Milk St., Boston, Mass.
448 c HOYT, W. E. ....Gen. Mgr., Monongahela Wood Preserving Co., 917 Citizens Bldg., Cleveland, Ohio.
498 c HUMPHREYS, C. L.....Paving Contractor, Ionia, Mich.
265 c HUNT, GEO. M........In Charge, Section of Wood Preservation, Forest Products Laboratory, Madison, Wis.

376 c INGALLS, E. E.........Chemist, Chicago, Burlington and Quincy Railroad, Box 442, Mount Vernon, Ia.
356 c ISAACS, JOHN D.......Consulting Engr., Southern Pacific Co., 165 Broadway, New York City.

252 c JACKSON, W. E........Supt., Texas Tie and Lumber Preserving Co., Somerville, Texas.
489 c JAEKLE, W. M........Asst. Engr. M. of Way and Struct., Southern Pacific, San Francisco, Cal.
124 c JENNISON, H. G.......Pres., The Jennison-Wright Co., Toledo, O.
260 c JOHNSON, J. A.........Supt. Tie Preserving Plant, Union Pacific Railroad, Box 604, Laramie, Wyoming.
401 a JORDAN, J. H..........Sales Div. Mgr., Grasselli Chemical Co., Cleveland, Ohio.
66 c JOYCE, A. R...........Joyce-Watkins Co., 332 S. Michigan Ave., Chicago, Ill.
147 c JUDGE, F. B...........4555 Ridge Ave., Glen Morris, Long Island, N. Y.
532 c JURS, LOUIS D........Chief Engr., Associated Oil Co., 817 Sharon Bldg., San Francisco, Cal.

205 c KAMMERER, A. L.....Consulting Timber Engr., von Schrenk & Kammerer, Tower Grove and Flad Avenues, St. Louis, Mo.
467 a KEHOE, H. B..........Salesman, Gillis & Co., Heyworth Bldg., Chicago, Ill.
222 c KEIG, J. R.............Gen. Tie and Timber Inspr., Atchison, Topeka and Santa Fe Railway, 925 Ry. Exchange Bldg., Chicago, Ill.
528 c KELLEHER, W. J......Gen. Mgr., Southern Creosoting Co., Ltd., Slidell, La.
315 h KENDRICK, J. W......Consulting Engr., 1733 Lytton Bldg., Chicago, Ill.
403 c KENNEDY, LEE T.....Inspr. of Treatment, Texas and Pacific and International and Great Northern Railroads, Houston, Tex.
281 c KENT, A. S............Chief Engr., Chicago, Indianapolis and Louisville Railroad, Chicago, Ill.
607 c KILLEY, R. M.........Mgr., Michigan Wood Preserving Co., Reed City, Mich. (1922).
492 c KIMBALL, L. P........Engr. of Buildings, Baltimore and Ohio Railroad, Baltimore, Md.
514 a KINKEL, R. P........117 Russell Ave., New York.
431 a KINSMAN, J. W........DuPont Chemical Works, Wilmington, Del.
574 a KINZEL, L. K.........Kinzel Lumber Co., Merrill, Wis.
488 c KIRKBRIDE, W. H....Engr. of Maint., Southern Pacific Co., San Francisco, Cal.
502 c KISTLER, L. W........Chemist, Santa Fe Tie and Lumber Preserving Co., Somerville, Texas.
542 c KITTLE, C. L..........Treating Inspector, Baltimore and Ohio Railroad, North Bend, Ohio.
566 c KNEELAND, R. E......Kettle River Company, Madison, Ill.
487 c KRELL, F. C..........Asst. Forester, Pennsylvania System, Broad St. Station, Philadelphia, Pa.
201 c KROEMER, F. W......Bernuth Lembcke Co., Inc., 421 W. 22nd Ave., Houston, Texas.
519 c KOFOID, CHAS. A......Prof. of Zoology, University of California, Berkeley, Cal.
162 c KUEHN, A. L..........Pres., American Creosoting Company, Louisville, Ky.

20 c LABROT, S. W.........Pres., American Creosote Works, New Orleans, La.
59 c LARKIN, A. E.........Mgr., Republic Creosoting Company, Box 274, St. Louis Park, Minn.
461 c LATIMER, J. D........International Creosoting & Construction Company, Galveston, Texas.
317 a LATTIMORE, C. H.....Pres., Creosoted Block Paving Co., Canadian Pacific Railroad Bldg., Toronto, Can.
96 c LAWSON, W. W........Supt. Plant, National Lumber and Creosoting Co., 312 Railway Exchange Bldg., Kansas City, Mo.
394 c LAWTON, THOS. A.....Sec'y, American Creosoting Co., 17 Battery Place, New York City.

608 c LAY, JOS. H...........Asst. Mgr., Michigan Wood Preserving Company, Reed City, Mich. (1922).
538 c LEAVITT, W. M. ......Western Cedar Pole Preservers, 547 Peyton Bldg., Spokane, Wash.
328 a LEE, ROBERT E......Pres., Hobart Lee Tie Co., Springfield, Mo.
40 a LEMBCKE, G. A.......Sec'y–Treas., Bernuth Lembcke Co., 171 Madison Ave., New York City.
517 a LEVERETT, W. H.....Supt., National Zinc Co., Kansas City, Kans.
110 a LEWIS, F. J...........Pres., F. J. Lewis Mfg. Co., 2500 S. Robey St., Chicago, Ill.
118 a LEWIS, W. H..........Vice Pres., F. J. Lewis Mfg. Co., 2500 S. Robey St., Chicago, Ill.
580 a LIBBERTON, J. H. ....General Chemical Co., 25 Broad St., New York City.
533 c LINDSLEY, E. A. ......Vice Pres. and Gen. Mgr., Western Wood Preserving Co., Spokane, Wash.
199 a LOCKETT, A. M........Pres., A. M. Lockett & Co., New Orleans, La.
12 c LOGAN, JOHN T........Pres., National Lumber and Creosoting Co., Texarkana, (Charter) Ark.
242 c LOOK, RICHARD V....Pres., Canada Creosoting Co., Toronto, Canada.
112 c LORD, RUSSELL ......Pres., Ayer and Lord Tie Co., 1515 Railway Exchange Bldg., Chicago, Ill.
633 c LORENZ, GEO. W......Tie and Timber Agent, Union Pacific Ry. System, Room 802 Union Pacific Bldg, Omaha, Neb. (1922).
61 c LOUD, H. S............Pres., Railway Tie Treating Co., Box 660, Syracuse, N. Y.
600 c LULL, H. M............Chief Engineer, Southern Pacific Lines, 916 Southern Bldg., Houston, Texas.

583 c MACLEAN, J. D........Engineer, Forest Products Laboratory, 315 Wisconsin Ave., Madison, Wis.
458 a MANDENBERG, E. C...Forester, The Barrett Co., 705 Laclede Gas Light Bldg., St. Louis, Mo.
345 p MANION, KERON .....Asst. Supt., American Creosoting Co. of New Jersey, Newark, N. J.
41 c MANLEY, R. S.........Pres., Creosoted Materials Co., 301 Queen and Crescent Bldg., New Orleans, La.
263 c MARRIOTT, F. G......Engr. of Tests, Dept. of Works, Toronto, Canada.
250 c MARTIN, F. R.........Mgr. Post and Pole Dept., Long-Bell Lumber Co., Marion, Ill.
336 a MARTIN, JAS. R.......Vice Pres., Western Silo Co., Des Moines, Ia.
137 c MATTOS, F. D..........Mgr. Treating Plants, Southern Pacific Co., West Oakland, Calif.
591 c MEYERS, R. E.........Care International Creosoting & Const. Co., Texarkana, Texas.
52 c McARDLE, FRANK ...Supt. Tie Plant, Indiana Zinc Creosoting Co., Terre Haute, Ind.
453 c McCORMICK, C. R......Pres., Chas. R. McCormick Co., 900 Fife Bldg., San Francisco, Cal.
555 a McCORMICK, H. F.....Mgr., St. Helens Lumber Co., St. Helens, Oregon.
415 c McCRORY, FRANK ....Chief Tie Inspr., Chicago, Rock Island & Pacific Railroad, Little Rock, Ark.
441 c McELHINNEY, H. G....Gen. Supt., The Kettle River Co., Madison, Ill.
434 c McGINTY, THOS. J.....Treating Inspr., Pennsylvania System, 1006 Century Bldg., St. Louis, Mo.
623 c McGOUGH, N. W.......Supervisor of Treatment, Texas & Pacific Ry. Co., Care International Creosoting & Construction Co., Texarkana, Texas (1922).
464 c McKEE, R. E..........Long-Bell Lumber Co., Kansas City, Mo.
113 c MEREDITH, W. C......Supt., Southern Wood Preserving Co., Atlanta, Ga.
419 c MERRITT, H. T........Supt., Indiana Tie Co., 904 Citizens' Bank Bldg., Evansville, Ind.
71 c MEYER, AUGUST .....Walsh Tie Co., 910 Security Bldg., Minneapolis, Minn.
474 c MEYER, E. H..........Vice Pres., St. Helens Creosoting Co., 913 Yeon Bldg., Portland, Oregon.
615 c MITCHELL, C. B.......Asst. to President, National Lumber and Creosoting Co., P. O. Box 712, Texarkana, Tex. (1922).
596 c MOFFATT, F. E........Control Chemist, Republic Creosoting Co., St. Louis Park, Minn.
164 c MOLL, DR. J. F........ 21 Brandenburgische St. Suedende, Berlin, Germany.
501 c MOODY, WALTER I...Asst. Secy., Denver Metals Co., Denver, Colo.
599 c MOORE, FRANK G.....Asst. Supt., Walsh Tie Co., 946–948 McKnight Bldg., Minneapolis, Minn.
520 a MOORE, GRANVILLE.. Pres., Metals & Chemicals Extraction Corporation, San Francisco, Cal.

254 c MOORE, ROBT. H.....Gen. Supt., Canada Creosoting Co., 1 King St. E., Toronto, Ontario.
576 c MORIER, L. E..........In Charge Pole Treating Plant, Naugle Pole and Tie Co., 55 Wabash Ave., Chicago, Ill.
545 c MORRIS, FRED N......Sales Mgr., Union Cedar Co., 1501-5 Second National Bank Bldg., Toledo, Ohio.
114 c MOSES, L. B............L. B. Moses & Son, 127 No. Dearborn St., Chicago, Ill.
309 c MURCHIE, W. E.......Cross, Austin & Ireland Lumber Co., 1246 Grand St., Brooklyn, N. Y.
351 c MURPHY, WM. B......Chief Chemist, F. J. Lewis Mfg. Co., 2500 S. Robey St., Chicago, Ill.
402 c MURRAY, D. L.........Supt., Atchison, Topeka and Santa Fe Treating Plant, Albuquerque, N. M.
621 c MUSSELMAN, C. B.....Chief Treating Inspector, Lehigh Valley R. R. Co., 231 West Franklin St., Bound Brook, N. J. (1922).
307 p MYERLY, J. R.........Treating Engr., Baltimore and Ohio Railroad, Green Spring, W. Va.

50 c NEWTON, H. M........Vice Pres. and Gen. Mgr., Midland Creosoting Co., Granite City, Ill.
634 a NEWMAN, R. M........Western Sales Mgr., Mineral Point Zinc Co., 1111 Marquette Bldg., Chicago, Ill. (1922).
585 c NIESSE, B. J...........Chemist, National Lumber & Creosoting Co., 312 Railway Exchange Bldg., Kansas City, Mo.
416 a NITCHIE, CHAS. C.....Chemist, Mineral Point Zinc Co., Depue, Ill.
283 a NIXON E. A............Vice Pres., Western Tie & Timber Co., St. Louis, Mo.
314 a NIXON, WARREN C....Vice Pres., Western Tie & Timber Co., St. Louis, Mo.

603 c OGLEVEE, O. S........Chief Treating Inspector, P. & L. E. R. R. Co., Dickerson Run, Pa. (1922).
455 c OLSON, JOHN ....Selling Agent, St. Helens Creosoting Co., 533 Van Nuys Bldg., Los Angeles, Cal.
589 a OLLIVER, J. H........Salesman, Gas Light & Coke Co., London Dauntsey House, Fredericks Place, Old Jewry, London, England.
570 a ONSTAD, A. H.........Engineer and Mill Architect, Weyerhaeuser Timber Co., Box 1607, Tacoma, Washington.
209 c OSBORNE, C. W........Plant Mgr., St. Helens Creosoting Co., 912-13 Yeon Bldg., Portland, Oregon.

253 c PARK, ERNEST S.....Vice Pres., Ohio Wood Preserving Co., 1053 Century Bldg., Pittsburgh, Pa.
268 c PARROTT, R. D........Pres. and Gen. Mgr., Atlantic Creosoting Co., Norfolk, Va.
404 c PAUL, C. E............Prof. of Mechanics, Armour Institute of Technology, Chicago, Ill.
271 c PAUL, H. A............Treating Inspr., Chicago, Rock Island and Pacific Railroad, Tie Plant, Ark.
450 c PEIMBERT, ANGEL ...Chief Engr., National Railways of Mexico, Colonia Station, Mexico City, Mex.
436 c PELZ, E. M............Treatment Inspr., Chicago, Milwaukee and St. Paul Railway, Evansville, Ind.
395 c PENNEY, JOHN S......T. J. Moss Tie Co., St. Louis, Mo.
462 c PEPPLER, R. A.........Supt., Pittsburgh Wood Preserving Co., Adelaide, Pa.
348 c PERSHALL, E. E......Vice Pres., T. J. Moss Tie Co., St. Louis, Mo.
191 c PESTEL, A. C..........Supt. Tie Treating Plant, Oregon-Washington Railroad and Navigation Co., Wyeth, Oregon.
115 c POOLER, F. S..........Tie Agent, Chicago, Milwaukee and St. Paul Railway, Chicago, Ill.
610 c POLLOCK, S. T........Asst. Supt., Ohio Wood Preserving Co., Orville, Ohio (1922).
500 c POST, C. F.............Ass't Purch. Agt., Western Pacific Railroad, Mills Bldg., San Francisco, Cal.
511 a POTTER, H. R.........Salesman, Potter-Coyle, Bessemer Bldg., Pittsburgh, Pa.
626 a PURDY, GEO. C........Pres., Greenlee Bros. Co., Rockford, Ill. (1922).
446 c PUSINELLI, J. A.......Treatment Inspr., Atchison, Topeka and Santa Fe Railway, Topeka, Kansas.
509 c POWELL, F. C.........Mgr., Republic Creosoting Co., Seattle, Wash.

396 a QUEENY, JOHN F.....Pres., Monsanto Chemical Works, 1800 S. Second St., St. Louis, Mo.

380 c RABOURN, M. M.......Treating Inspr., Union Pacific Ry. Co., Laramie, Wyo.
581 a RAILTON, E. M........Sales Mgr., Barrett & Co., 10 South LaSalle St., Chicago, Ill.
261 c RAWSON, R. H........Goss and Rawson, 1124 Yeon Bldg., Portland, Oregon.
331 c RAY, JOHN R..........433 S. Galvez St., New Orleans, La.
155 c RECORD, S. J..........Prof. of Forest Products, Yale University, New Haven, Conn.
627 a REILLY, P. C..........President, Republic Creosoting Co., Indianapolis, Ind. (1922).
617 c REISER, LEO J........Asst. Supervisor Tie and Timber Dept., C., R. I. & P. Ry. 1140 White Ave., Kansas City, Mo. (1922).
579 c REYES, LUIS J........Asst. Wood Expert, Bureau of Forestry, Manilla, Philippine Islands.
614 c REYNOLDS, J. P.......Supervisor of Treatment, St. L. & S. W. Ry. Co., P. O. Box 208, Texarkana, Tex. (1922).
54 c REX, GEO. E..........Vice Pres., National Lumber & Creosoting Co., 312 Railway Exchange Bldg., Kansas City, Mo.
526 a RHODES, E. O.........Chemical Director, American Tar Products Co., 610 So. Federal St., Chicago, Ill.
597 c RHYNE, WADE H.....Timber Treating Inspector, Southern Ry. Co., 1233 E. 20th St., Jacksonville, Fla.
228 a RIDSDALE, P. S .....Secy., American Forestry Assn., Washington, D. C.
585 c RITCHIE, A. BRUCE...Mining Engr., Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, B. C.
578 c ROACH, D. E..........Secy. and Treas., Creosoted Materials Co., Inc., 301 Queen and Crescent Bldg., New Orleans, La.
549 a ROCCA, B. T...........Engr., Metals and Chemical Extraction Corporation, 766 50th Avenue, Oakland, Cal.
133 c RODD, THOS., JR......Pres., The Rodd Co., Century Bldg., Pittsburg, Pa.
14 c ROLLINS, H. M.........Supt., Gulfport Creosoting Co., Gulfport, Miss.
(Charter)
363 c ROSS, PERCY A........Supt. Treating Plant, El Paso and Southwestern Railroad, Alamogordo, N. M.
310 c ROWLAND, J. W.......Gen. Tie Inspr., Baltimore and Ohio Railroad, Parkersburg, W. Va.
90 c RUFLI, H. M...........Supt., Republic Creosoting Co., Indianapolis, Ind.
556 c RUSSELL, WM. A......Inspr. Green and Creosoted Material, R. W. Hunt Co., St. Helens, Oregon.
465 c RYAN, THOS. J........Chief Tie and Timber Inspr., Chicago & Eastern Illinois Railroad, 307 S. Market St., Marion, Ill.

286 c SACKETT, H. S........Ass't Purch. Agt., Chicago, Milwaukee and St. Paul Railway, Chicago, Ill.
398 c SCHILTHUIS, J. J......United Indian Wood Exploitation Companies, Semarang, Java.
619 c SCHJOTH, PERCY ....Supt., T. J. Moss Tie Co., Granville, Wis. (1922).
567 a SCHLAFLY, J. J.......Vice Pres., Potosi Tie & Lumber Co., 410 Liberty Central Bldg., St. Louis, Mo.
496 c SCHMAELZLE, K. J....Sales Engr., Jennison-Wright Co., Toledo, Ohio.
206 c SCHNATTERBECK, C.C.Special Inspector in Charge Cross-ties, U. S. R. A., 904 Hurley-Wright Bldg., Washington, D. C.
513 a SCHOELLKOPF, J.F., JR.Pres., By-Products Steel Corporation, 706 Marine Trust Bldg., Buffalo, N. Y.
189 c SCHOMBURG, T. A....Pres., Continental Tie and Lumber Co., Denver, Colo.
85 c SCHULZ, HARRY .....Supt., Wood Preserving Plant, Salt Lake Route, Los Angeles, Cal.
592 c SHAR, CHUAN-SHOW..205 Linden Ave., Ithaca, N. Y.
432 c SHINN, FORREST S....Supervisor, Chicago, Burlington & Quincy Treating Plant, Galesburg, Ill.
51 c SHIPLEY, GRANT B...Pres., Pittsburgh Wood Preserving Co., Century Bldg., Pittsburgh, Pa.
373 c SHIPLEY, JACK B.....Pittsburgh Wood Preserving Co., Century Bldg., Pittsburgh, Pa.
154 a SHIPLEY, L. B ....Bernuth Lembcke Co., 171 Madison Ave., New York City.
89 c SHUFORD, C. S........Mgr., Republic Creosoting Co., Norfolk, Va.
15 c SMITH, AMOS..........Supt., Ayer and Lord Tie Co., Argenta, Ark.
(Charter)
45 c SMITH, LOWRY ......Ass't Div. Engr. Eastern District, Northern Pacific Railroad, St. Paul, Minn.
34 c SMITH, P. A...........Ass't Mgr., Norfolk Creosoting Co., Norfolk, Va.
289 a SMITH, R. G..........Engr. and Chem., Standard Oil Co. of California, 200 Bush St., San Francisco, Cal.
216 c SMITH, V. C...........Cons. Engr., Government Railroads of India, Care Parr's Bank, Haverstock Hill, London, N. W., England.

421 c SMITH, WM. D........Cain–Hurley Lumber Co., 1153 People's Gas Bldg., Chicago, Ill.
135 c SMITH, W. J..........Tie and Timber Agent, Missouri, Kansas and Texas Railroad, St. Louis, Mo.
463 c SNOW, IRVING M......Ass't Supt., Pittsburgh Wood Preserving Co., Adelaide, Pa.
504 c SNYDER, C. H.........Cons. Civil Engr., 251 Kearny St., San Francisco, Cal.
558 c SPECHT, J. M..........Tie Agent, Southern Pacific Railway, 719 Yeon Bldg., Portland, Oregon.
470 c SPENCER, WM. O......Supt., Wood Preserving Works, Southern Pacific Co., Los Angeles, Cal.
355 c SPORLEY, CHAS. M....National Pole Co., 742 Metropolitan Bldg., Minneapolis, Minn.
427 c SPROAT, ROBT. ......Chief Lbr. Inspr., Central Railroad of New Jersey, Port Reading Creosoting Plant, Port Reading, N. J.
248 c STAHL, K. F..........Consulting Chemist, General Chemical Co., 2318 Wharton St., Pittsburgh, Pa.
104 c STEINMAYER, O. C....Supr. Timber Pres., St. Louis–San Francisco, Springfield, Mo.
638 c STEPHENSON, G. C....Chemist, Care Manager Treating Plants System, A. T. & S. F. Ry. Co., Topeka, Kans. (1922).
58 c STERLING, E. A.......Eastern Mgr., J. D. Lacey & Co., 350 Madison St., New York City.
35 c STEWART, F. H.......2201 Pittsburg Ave., El Paso, Texas.
605 c STEELE, THOS. F......Pres., Creosote Supply Co., 904 Hibernia Bldg., New Orleans, La. (1922).
620 c STEEN, WM. ....Manager, Long–Bell Lumber Co., Box 460 Shreveport, La. (1922).
506 c STIBOLT, V. A.........Ass't Gen. Mgr., Natalbany Lumber Co., Hammond, La.
92 c STIMSON, EARL ......Chief Engr. Maintenance, Baltimore and Ohio Railroad, Baltimore, Md.
375 c STOCKDALE, J. S......Purch. Agt., Pittsburgh Wood Preserving Co., Century Bldg., Pittsburgh, Pa.
285 c STOCKING, E. J........Vice Pres., Central Creosoting Co., 111 W. Washington St., Chicago, Ill.
429 c STOTTLEMYER, E. M..Gen. Foreman, Baltimore and Ohio Treating Plant, Green Spring, W. Va.
572 a STREHAN, GEO. E....Cons. Engr., Southern Pine Association, 112 West 42nd St., New York City.
471 a STROTHER, GRAY O..62 Essex Ave., Glen Ridge, New Jersey.
312 c STULL, T. G..........Chief Timber Inspr., Chicago, Indiana and Louisville Railway, Bloomington, Ind.
287 c SWAN, O. T............Sec'y, Northern Hemlock and Hardwood Manufacturers' Association, Oshkosh Wis.

36 c TAYLOR, C. M.........Supt. Treating Plant, P. & R. and C. R. R. of N. J., Port Reading, N. J.
304 c TAYLOR, THOS. B.....Ass't to Pres., American Creosoting Co., Louisville, Ky.
430 c TEBBY, C. E..........T. J. Moss Tie Co., R. R. 1, Box 147, East St. Louis, Ill.
192 c TILLEY, C. M..........Timber Treating Inspr., Southern Railway, Slidell, La.
197 c TOWNSEND, T. G......50 East 58th Street, New York City.
16 a TOWNLEY, WM., JR....Grasselli Chemical Co., Cleveland, Ohio.
(Charter)
382 c TRACEY, JOHN H.....Timber Inspr., Testing Division, City of Chicago, 3100 S. Sacramento Ave., Chicago, Ill.
466 a TRUMAN, M. G........Vice Pres., Carter Bloxonend Flooring Co., 332 S. Michigan Ave., Chicago, Ill.
139 c TRUMBULL, M. K......American Sugar Refining Co., 117 Wall St., New York City.

17 c VALENTINE, H. S......Ass't Gen. Mgr., Eppinger and Russell Co., 165 Broadway, New York City.
(Charter)
439 c VANDERPOEL, W. K....Gen. Supt. Distribution, Public Service Electric Co., 80 Park Place, Newark, N. J.
65 c VAN METRE, R........Vice Pres., Joyce–Watkins Co., 332 S. Michigan Ave., Chicago, Ill.
602 c VAUGHAN, J. ALVIN...Plant Chemist, Norfolk & Western Ry. Co., P. O. Box 280, East Radford, Va.
523 c VESEY, ROBT. S.......Works Mgr., Wm. Christie & Co., Ltd., Christies Wharf, London S. E. 7, England.
141 c von LEER, H. J........Treating Inspr., Baltimore and Ohio Railroad, 601 S. 8th St., Terre Haute, Ind.
46 c von SCHRENK, H......Cons. Timber Engr., Tower Grove and Flad Avenues, St. Louis, Mo.

584 c VOLMER, MILTON J...Supervisor of Treatment, National Lumber & Creosoting Co., Box 63, Leeds, Mo.
378 c VORUM, A. H..........Inspection Engr., Western Electric Co., 195 Broadway, New York City.

326 c WADDELL, K. M.......Chemist, Jennison–Wright Co., Toledo, Ohio.
256 c WALLACE, H. ....Supt., American Creosoting Co., 401 W. Main St., Louisville, Ky.
543 c WALSH, LIONEL O. P...Gen. Mgr., Dominion Tar & Chemical Co., 171 James St., Montreal, Quebec.
111 a WALSH, P. R..........Pres., Walsh Tie Co., Security Bldg., Minneapolis, Minn.
468 c WALTER, FRED J....Nashville, Chattanooga and St. Louis Railroad, Nashville, Tenn.
420 c WASTJER, JOSEPH ..Sec'y, Indiana Tie Co., Evansville, Ind.
81 c WATERMAN, J. H.....Supt. Timber Preservation, Chicago, Burlington and Quincy Railway, Galesburg, Ill.
150 o WATKINS, W. T.......Pres., Joyce–Watkins Co., 332 S. Michigan Ave., Chicago, Ill.
551 a WAUGH, FRANK A....Walter Waugh and Co., 4 Lloyd's Ave., London, England.
387 c WEATHERLY, J. L.....Sales Engr., Jennison Wright Co., 906 Crozer Bldg., Philadelphia, Pa.
134 c WEBER, J. M..........Supt., Ohio Wood Preserving Co., Orrville, Ohio.
305 a WEGENER, RICH...... Pres., Standard Tar Products Co., Milwaukee, Wis.
79 h WEISS, H. F...........Cons. Engr., C. F. Burgess Laboratories, Madison, Wis.
516 c WEST, O. R............Div. Engr., Atchison, Topeka and Santa Fe Railway, Needles, Calif.
469 a WETMORE, W. C......Residual Oils Corporation, 1313 People's Gas Bldg., Chicago, Ill.
565 a WHEELER, CHAS. L... Gen. Mgr., St. Helens Dock & Terminal Co., St. Helens, Oregon.
484 c WHITE, FRANK G.....Chief Engr., Board of State Harbor Commissioners, Ferry Bldg., San Francisco, Cal.
177 c WHITE, THOS. M......American Creosote Works, Louisville, Miss.
613 c WHITE. R. H., JR......Vice Pres., Southern Wood Preserving Co., Atlanta, Ga. (1922).
437 c WILKINSON, J. M.....912 W. Chestnut St., Marion, Ill.
47 c WILLIAMS, J. C.......Inspector, Port Reading Creosoting Plant, Port Reading, N. J.
497 c WILLIAMS, J. W.......Chief Engr., Northwestern Pacific Railroad, 64 Pine St., San Francisco, Cal.
138 c WILLIAMS, R. R.......Pres. and Treas., Indiana Tie Co., Evansville, Ind.
399 c WILSON, ROGER ......Chemist, Republic Creosoting Co., Minneapolis, Minn.
478 c WILTSEE, W. P........Ass't Engr., Norfolk and Western Ry., Roanoke, Va.
643 c WINEGAR, B. M........Ass't Gen. Tie Agent, Canadian Pacific Ry. Co., Montreal, Canada (1922).
426 c WOOD, GALEN ....Chemist, Philadelphia and Reading Railroad, Port Reading, N. J.
575 c WOOD, O. H...........Ass't Purch. Agt., Great Northern Railroad, 324 King St., Seattle, Wash.
540 a WOOD, WM. PHILO....Tar Products Corporation, 913 Turks Head Bldg., Providence, Rhode Island.
459 c WOODRUFF, H. W., JR...Gen. Mgr., Hattiesburg Creosoting Co., Hattiesburg, Miss.
485 c WYMAN, R. L..........Inspector, Pacific Coast Forest Products, 437 Pittock Block, Portland, Oregon.

344 c ZELLER, W. C.........Supt., American Creosoting Co. of New Jersey, Newark, N. J.
637 c ZIMMERMAN, C. W....Engineer in Forest Products, Box 112 University Station, Seattle, Washington (1922).

ATTENDANCE AT THE EIGHTEENTH ANNUAL MEETING

The registration showed the following in attendance at the meeting:

Members

Adams, Chas.
Alexander, E.E.
Amadon, C. H.
Amis, J. C.
Angier, F. J.
Armstrong, A. W.
Austin, H. E.

Bacon, W. L.
Bade, J. H.
Barth, Kurt C.
Bateman, Ernest
Belcher, R. S.
Boehne, E. E.
Bowser, E. H.
Briggs, Z. M.
Brown, Nelson C.
Bradley, Mark K.
Buehler, Walter
Burnes, J. D.
Bush, H. O.

Calvin, R. A.
Card, Joseph B.
Cate, T. A.
Cecil, W. A.
Cherrington, F. W.
Chilcoat, G. W.
Church, S. R.
Clifton, W. H.
Clark, E. L.
Cooper, S. D.
Crawford, Carl G.
Condon, H. R.
Curtin, Matthew J.

Davidson, G. M.
Davis, H. E.
Davis, C. T.
Davis, J. W.
Deutsch, Margaret F.
Dixon, G. C.
Drefahl, L. C.
Dunstan, J. H.
Dutton, Ellis R.
Dwyer, M. B.

Edwards, D. W.
Elder, S. M.
Enright, F. M.
Ericson, Lambert T.

Frey, Geo. W.
Foley, John
Ford, C. F.
France, R. L.
Fritz, C. C.
Fulks, E. B.
Fulweiler, W. H.
Furlong, L. A.

Gerhard, Harry H.
Gibson, Andrew
Golden, W. J.
Goltra, W. F.
Goodwin, W. R.
Grady, W. H.
Graham, F. N.
Graham, R. A.
Greene, C. W.
Greenebaum, Milton
Grow, J. H.

Harper, Lewis H.
Hartman, Ernest F.
Heim, A. L.
Hendricks, V. K.
Hicks, P. R.
Hicks, S. D.
Horrocks, H. E.
Hosford, Roger F.
Hoskins, J. W.
Howson, E. T.
Hunt, Geo. M.

Jackson, W. E.
Johnson, J. A.
Johnson, John H.
Joyce, A. R.
Jurs, L. D.

Kammerer, Alfred L.
Kehoe, H. B.
Keig, J. R.
Kelleher, W. J.
Killey, R. M.
Kinsman, J. Warren
Kistler, L. W.
Krell, F. C.
Kroemer, F. W.
Kuehn, A. L.

Laist, Theo. F.
Larkin, A. E.
Lay, Joseph H.
Lembcke, G. A.
Lewis, F. J.
Lewis, W. H.
Lord, Russell
Lorenz, G. W.

McCrory, Frank
McElhinney, H. G.
McGinty, Thomas J.
McKee, R. E.
MacLean, J. D.
Mandenberg, E. C.
Mattos, F. D.
Manley, R. S.
Martin, F. R.
Meyer, A.

Meyers, R. E.
Morier, L. E.
Moses, L. B.
Murray, D. L.

Niesse, Bernard J.
Newton, H. M.
Nixon, Warren C.

Oglevee, O. S.

Park, E. S.
Paul, C. E.
Paul, H. A.
Pelz, E. M.
Penney, John S.
Pershall, E. E.
Pooler, F. S.
Potter, H. R.

Rabourn, M. M.
Reiser, Leo J.
Rex, Geo. E.
Rhodes, E. O.
Rhyne, Wade H.
Roach, D. Eggleston
Ross, P. A.
Rowland, J. W.

Schjoth, Percy
Schlafly, J. F.
Schnatterbeck, C. C.
Shinn, Forrest S.
Smith, Lowry
Smith, Wm. D.
Smith, W. J.
Snow, Irving M.
Steen, Wm.
Steinmayer, O. C.
Stocking, E. J.
Stull, T. G.
Swan, O. T.

Taylor, C. Marshall
Tebby, C. E.
Tilley, C. M.

Valentine, H. S.
Van Metre, R.
Volmer, Milton J.
von Leer, H. J.
von Schrenk, H.
Vorum, A. H.

Waddell, K. M.
Walsh, P. R.
Walter, F. J.
Waterman, J. H.
White, R. H., Jr.
Wood, Galen

Non-Members

Aishton, R. H.
Angier, Robert N.
Auguera, F.
Ansley, F. J., Jr.

Babcock, A. T.
Baird, Thomas
Bartsch, Paul
Bennett, Alfred
Berger, Anton J.
Blomberg, K. A.
Bowden, I. V.
Brodeson, R. J.
Brown, Sandford
Burt, Clarence

Campbell, J. Hayes
Cannon, Jos.
Chilcoat, Robt. F.
Clark, W. A.
Cobley, A. W.
Coderre, J. A.
Colley, Reginald H.
Cordin, E. F.
Cox, Vernon J.

Deabler, C. O.
DeBerard, W. W.
Defebaugh, E. H.
Drake, R. E.

Edmonds, Chas. H.
Egloff, H. Gustav
Ehrhart, E. D.
Ehrhart, E.
Eifel, L. S.

Fathman, A. R.
Fielder, A.
Filmer, Walter L.
French, A. C.
Fritschle, J. C.
Fox, Ed
Fuhr, Fred L.

Garrett, James
Geissmann, Theodore
Gilbert, F. A.
Gowing, E. P.
Greene, W. H.
Greenhager, Milton
Gurtler, Frederick H.

Hagen, A. M.
Harmount, Timmons
Hayden, Virgil
Hempelmann
Hillier, F. S.
Humphrey, C. J.
Hornan, Elmer

Jacobs, O. E.
Johnson, B. N.
Jones, G. H.

Kelley, D. E.
Kelly, Ed
Knowles, C. R.

Livingston, Robert D.
MacCart, W. F.
McGinty, Michael
McGunera, Jas. R.
Marlowe, L. D.
Mossey, O. L.
Menzer, P. J.
Miller, H. O.
Mitchell, W. L.
Moss, F. J.
Mummert, M. A.
Musselman, C. B.

Paul, W. A.
Peele, H. J.
Poleman, Walter
Purdy, George C.

Roseman, B. H.
Roth, H.

Schussler, M. H.
Scribner, C. S.
Severence, O. W.
Smith, E. C.
Steel, D. A.
Strawn, H.
Summerhays, W. A.

Van Hafften, A. W.

Weisenburger, F. W.
Wells, W. F.
White, L. H.
Woolf, H. C.

CLASSIFICATION OF MEMBERSHIP

Railroads

ATCHISON, TOPEKA & SANTA FE:
- Belcher, R. S.
- Brennan.T. S.
- Cooper, S. D.
- Curry, J. H.
- Faulkner, E. O.
- Frandsen, F. K. O.
- Jackson, W. E.
- Keig, J. R.
- Murray, D. L.
- Pusinelli, J. A.
- Stephenson, G. C.
- West, O. R.

BALTIMORE AND OHIO:
- Alexander, E. E.
- Angier, R. N.
- Elder, Samuel
- Gross, H. W.
- Kimball, L. P.
- Kittle, C. L.
- Myerly, J. R.
- Rowland, J. W.
- Stimson,, Earl
- Stottlemyer, E. M.
- Von Leer, H. J.

CANADIAN PACIFIC:
- Dixon, J. H.
- Winegar, B. M.

CENTRAL OF GEORGIA:
- Harper, L. H.

CHICAGO, BURLINGTON & QUINCY:
- Hagglander, G. A.
- Ingalls, E. E.
- Shinn, F. S.
- Waterman, J. H.

CHICAGO & EASTERN ILLINOIS:
- Bernhardt, J. E.
- Ryan, T. J.

CHICAGO & GREAT WESTERN:
- Graham, F. N.

CHICAGO, INDIANAPOLIS & LOUISVILLE:
- Kent, A. S.
- Stull, T. G.

CHICAGO, MILWAUKEE & ST. PAUL:
- Pelz, E. N.
- Pooler, F. S.
- Sackett, H. S.

CHICAGO & NORTHWESTERN:
- Bacon, W. L.
- Bemis, Geo. M.
- Davidson, Geo. M.

CHICAGO, ROCK ISLAND & PACIFIC:
- Ford, C. F.
- McCrory, Frank
- Paul, H. A.
- Reiser, Leo J.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS:
- Dixon, G. C.

DELAWARE, LACKAWANNA & WESTERN:
- Gosline, C. E.

DETROIT & MACKINAC:
- Amis, J. C.

DULUTH & IRON RANGE:
- Clark, W. A.

EL PASO & SOUTHWESTERN:
- Ross, P. A.

ERIE RAILROAD:
- Bush, H. O.
- Falconer, R. C.

GOVERNMENT RAILROADS OF INDIA:
- Smith, V. C.

GREAT NORTHERN:
- Wood, O. H.

ILLINOIS CENTRAL:
- Bowser, E. H.

KANSAS CITY SOUTHERN:
- Bowden, I. V.

LEHIGH VALLEY:
- Musselman, C. B.

MISSOURI, KANSAS & TEXAS:
- Elam, Wm.
- Smith, W. J.

MISSOURI PACIFIC:
- Graham, R. A.

MINNEAPPOLIS, ST. PAUL, SAULT STE. MARIE:
- Goodwin, W. R.

NATIONAL RAILWAYS OF MEXICO:
- Peimbert, Angel

NASHVILLE, CHATTANOOGA & ST. LOUIS:
- Walter, F. J.

Railroads—(Continued)

NEW YORK CENTRAL:
- Green, C. W.
- Bury, Richard A.

NORFOLK & WESTERN:
- Bell, H. C.
- Gibboney, J. H.
- Vaughan, J. Alvin
- Wiltsee, W. P.

NORTHERN PACIFIC:
- Gibson, Andrew
- Smith, Lowry

NORTHWESTERN PACIFIC:
- Williams, J. W.

OREGON SHORT LINE:
- French, A. C.

OREGON-WASHINGTON RAILROAD & NAVIGATION CO.:
- Pestel, A. C.

PENNSYLVANIA:
- Black, J. M.
- Briggs, Z. M.
- Chilcoat, G. W.
- Condon, H. R.
- Foley, John
- Hopkins. H. W.
- Krell, F. C.
- McGinty, T. J.

PHILADELPHIA & READING:
- Sproat, R.
- Taylor, C. M.
- Williams, J. C.
- Wood, Galen

PITTSBURGH & LAKE ERIE:
- Clarke, Roy C.
- Oglevee, Oliver S.

ST. LOUIS & SAN FRANCISCO:
- Steinmayer, O. C.

ST. LOUIS & SOUTH WESTERN:
- Reynolds, J. P.

SAN FRANCISCO-OAKLAND TERMINAL:
- Harris, Geo. H.

SAN PEDRO, LOS ANGELES & SALT LAKE:
- Schulz, Harry

SOUTHERN:
- Finke, W. F. H.
- Rhyne, Wade H.
- Tilley, C. M.

SOUTHERN PACIFIC:
- Adams, Charles
- France, R. L.
- Isaacs, John D.
- Jaekle, W. M.
- Kirkbride, W. H.
- Lull, H. M.
- Mattos, F. D.
- Specht, J. M.
- Spencer, W. O.

TEXAS AND NEW ORLEANS:
- Davis, Charles T.

TEXAS & PACIFIC:
- McGough, N. W.

TEXAS & PACIFIC AND INTERNATIONAL AND GREAT NORTHERN:
- Kennedy, L. T.

UNION PACIFIC:
- Johnson, J. A.
- Lorenz, Geo. W.
- Rabourn, M. M.

WESTERN PACIFIC:
- Post, C. F.

Street Railways

BOSTON ELEVATED RAILWAY COMPANY:
- Curtin, M. J.

Commercial Treating Plants

AMERICAN CREOSOTING COMPANY:
- Austin, H. E.
- Crawford, C. G.
- Durham, J. H.
- Gowing, E. P.
- Grady, W. H.
- Kuehn, A. L.
- Lawton, T. A.
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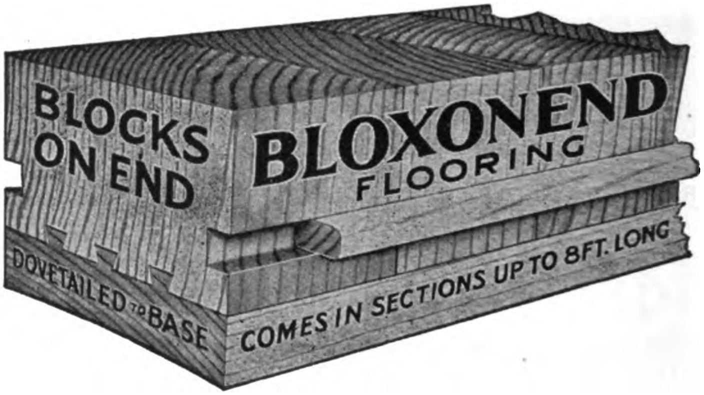

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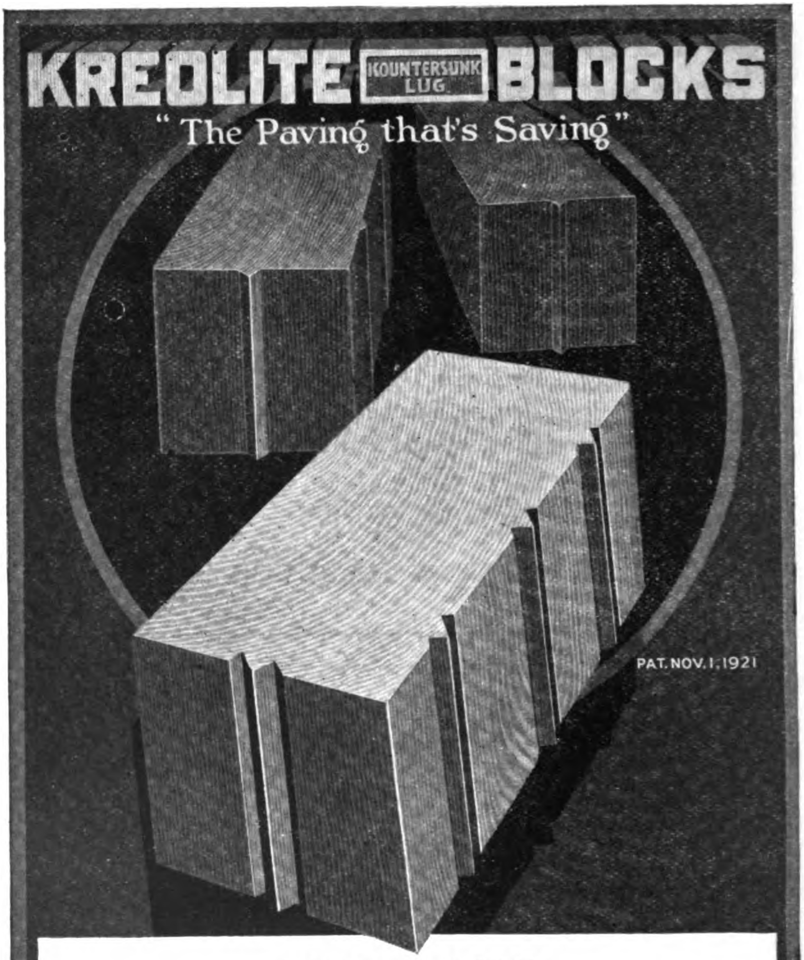

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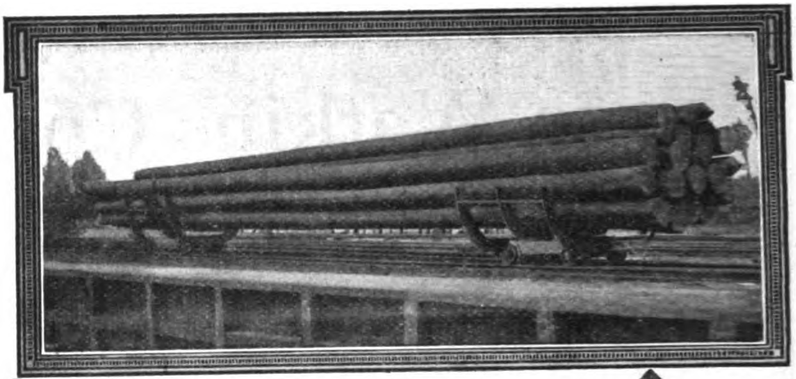

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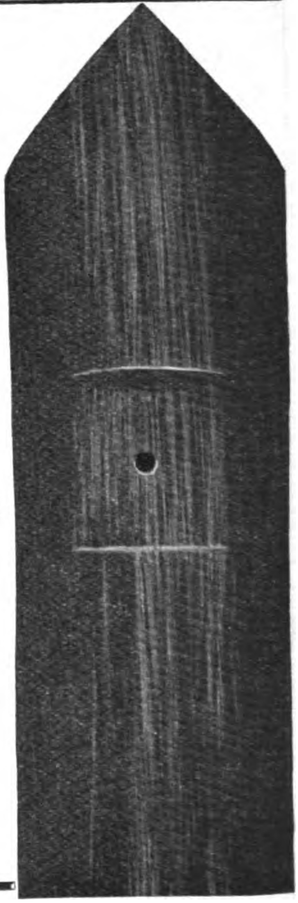

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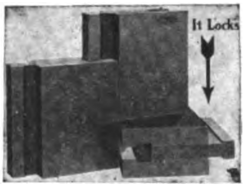

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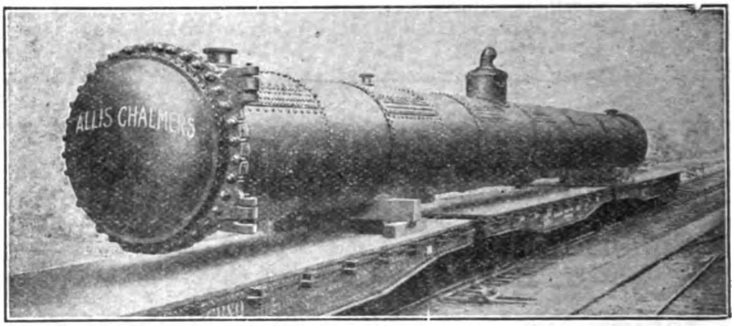

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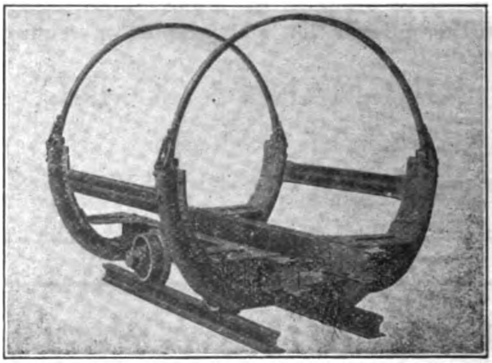

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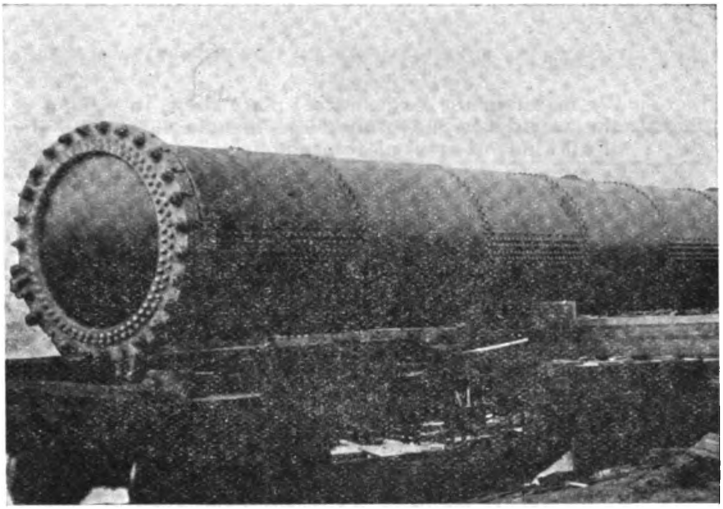

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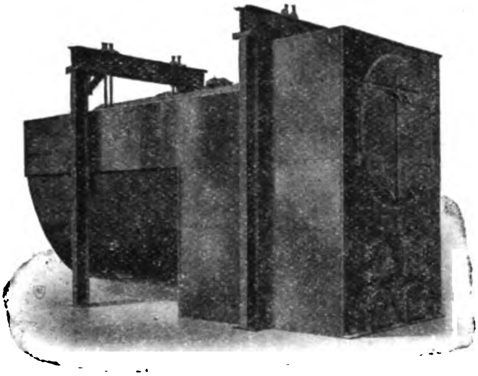

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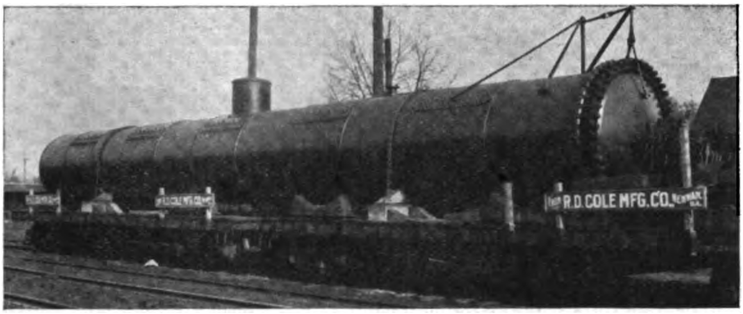

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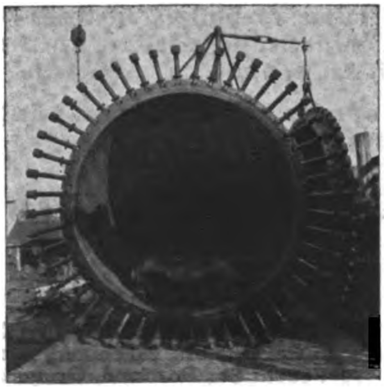

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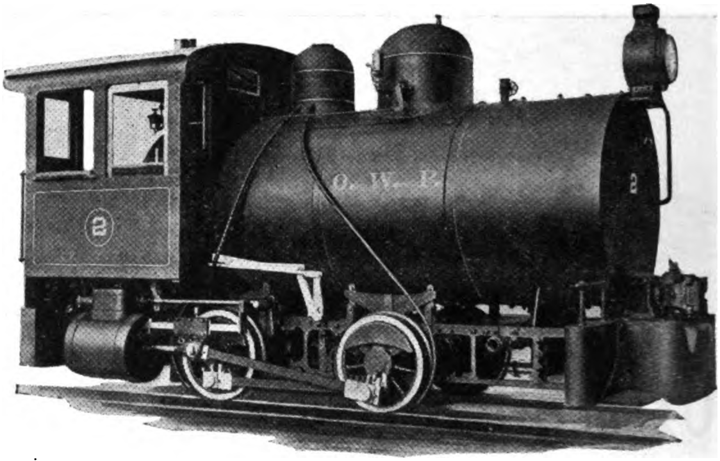

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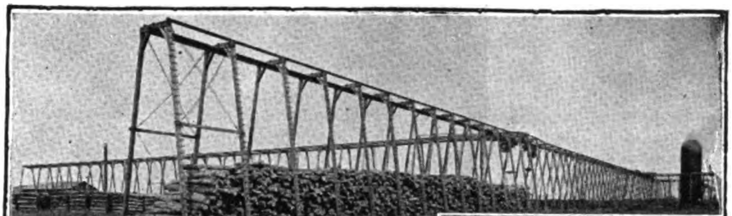

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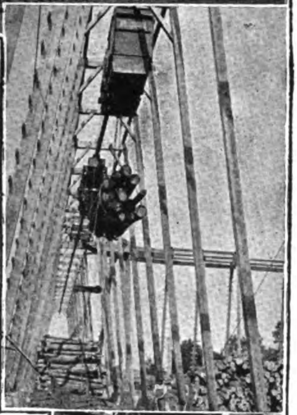

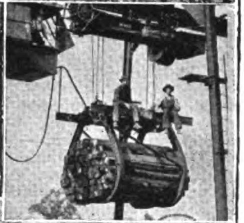

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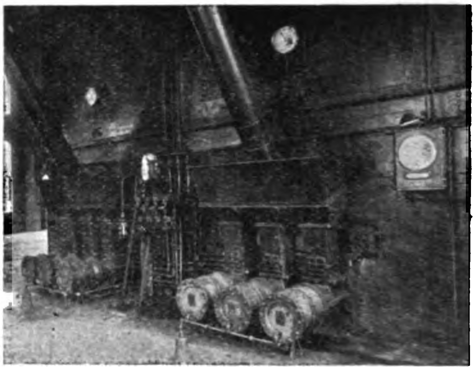

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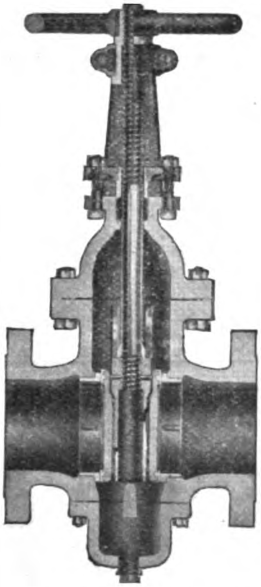

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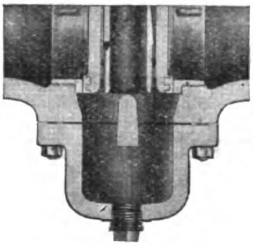

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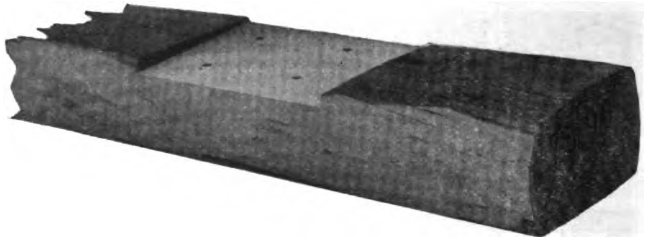

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